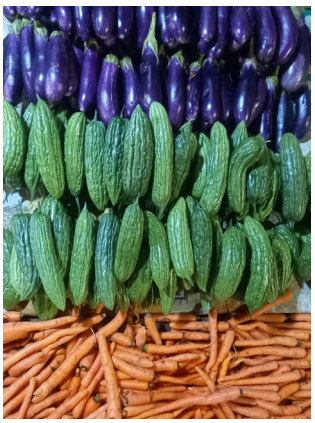
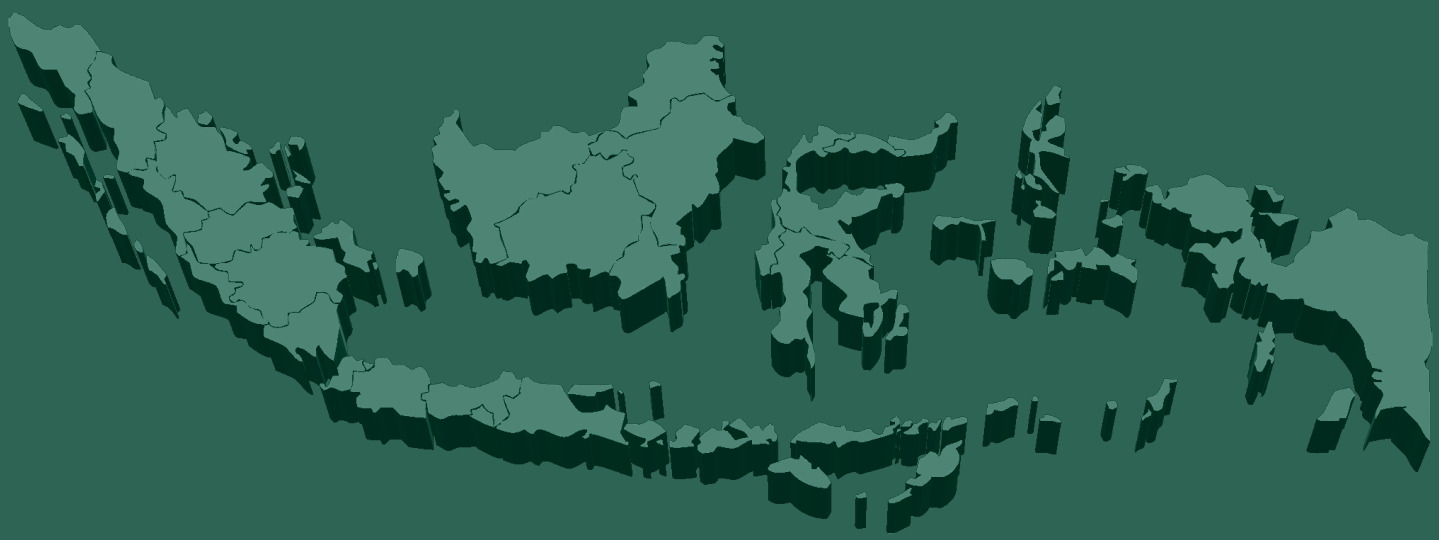
NATIONAL ADAPTATION PLAN (NAP) REPUBLIC OF INDONESIA

2026–2030
on The Pathway Toward 2035



NATIONAL ADAPTATION PLAN (NAP)
REPUBLIC OF INDONESIA
2026–2030 on The Pathway Toward 2035

Prepared by

Directorate of Climate Change Adaptation
Deputy Minister for Climate Change and Carbon Governance
Ministry of Environment/Environmental Protection Agency
Republic of Indonesia

Supported by

Acknowledgement

The document was prepared by Ministry of Environment/ Environmental Protection Agency with the support of the German Federal Ministry for the Environment, Climate Action, Nature Conservation and Nuclear Safety (BMUKN) through International Climate Initiative (IKI) funded projects implemented by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH – Climate and Biodiversity Hub Indonesia & BIOCLIME, and GCF Readiness Funds for NAP Project titled 'Accelerating Climate Change Adaptation Investment Planning to Enhance Resilience in Indonesia' implemented by the United Nations Development Programme (UNDP).

FOREWORD

Indonesia has consistently demonstrated that climate adaptation is not a peripheral agenda, but a central pillar of sustainable development. Our geographic position as a vast archipelagic state with high exposure to sea-level rise, extreme weather, and ecosystem degradation demands a response that is comprehensive, forward-looking, and firmly embedded in national development pathways. Indonesia's National Adaptation Plan (NAP) represents a national framework that translates the commitments in Enhanced Nationally Determined Contribution (ENDC) into a coherent set of operational measures.

The NAP is not written in isolation. It consolidates and builds upon a sequence of strategic national instruments that together trace Indonesia's adaptation journey. The NDC Roadmap on Adaptation (2020) provided a structured foundation; the Pembangunan Berketahanan Iklim/Climate Resilience Development (PBI, 2021) operationalized resilience-building in practice; the ENDC (2022) and Adaptation Communication (2022) elevated Indonesia's ambition and visibility internationally; the Health National Climate Change Mitigation and Adaptation Plan 2025 - 2029 (RANMAPIK, 2025-2029), while the Climate Landscape Analysis for Children (CLAC, 2023), Rencana Aksi Nasional Gender dan Perubahan Iklim/ National Action Plan on Gender and Climate Change (RAN-GPI, 2024) expanded the scope of adaptation to address social equity, gender and community.

This NAP is deliberately aligned with the nation's medium- and long-term development priorities. By embedding adaptation into the National Medium-Term Development Plan (RPJMN) 2025–2029, the National Long-Term Development Plan (RPJPN) 2025–2045, Sustainable Development Goals (SDG's) (Goal 13 Climate Action), and the Indonesian Biodiversity Strategy and Action Plan (IBSAP 2025–2045), Indonesia underscores that climate resilience is inseparable from economic growth, social protection, and biodiversity conservation.

Indonesia's NAP defines how adaptation will be implemented across priority sectors (food, water, health, ecosystems and energy). This is in line with President's vision of Asta Cita to achieve self-sufficiency in food, water, and energy. It sets measurable baselines and targets, introduces a monitoring, evaluation and learning (MEL) framework, and identifies mechanisms for mobilizing finance and technology. By doing so, it transforms commitments into pathways of change, ensuring that NDC is not simply a declaration but a lived reality.

Indonesia's capacities are evident in this process: strong institutional arrangements, a growing body of scientific evidence and inclusive participatory mechanisms that engage ministries, local governments, civil society organization, communities, academia, and private sector. At the same time, addressing the escalating impacts of climate change requires enhanced international support, technologies tailored to local contexts, and capacity-building that empowers all levels of governance. These needs are not expressions of weakness, but of recognition that adaptation is a shared global responsibility, consistent with the principles of equity and common but differentiated responsibilities.

Finally, this NAP places Indonesia firmly within the global adaptation architecture. It contributes to the Global Goal on Adaptation (GGA), aligns with the Enhanced Transparency Framework (ETF), and envisions the operationalisation of the Loss and Damage framework, acknowledging that some impacts are unavoidable and must be addressed. In this regard, the NAP serves as both a national roadmap and an international contribution - an adaptive framework that will evolve over time in line with scientific progress, policy development, and experiences.

On behalf of the Government of Indonesia, I extend appreciation to all who contributed to this effort. This NAP is both a statement of our determination and an invitation for collaboration. May it serve as a practical guide to resilience for Indonesia, and as a meaningful contribution to the collective effort of building a climate-resilient world.

Jakarta, November 2025

Hanif Faisol Nurofiq

Minister of Environment
Head of Environmental Protection Agency
Republic of Indonesia

PREFACE

Indonesia reiterates its firm commitment to advancing climate-resilient national development. Following the Enhanced Nationally Determined Contribution (2022), the submission of the Second NDC (2025), Indonesia continues to strengthen its strategic direction and ambition to address the escalating impacts of climate change. The National Adaptation Plan (NAP) serves as a national framework to guide coherent, integrated, and forward-looking adaptation actions across all levels of governance.

This NAP sets out priority adaptation measures across five key systems essential to Indonesia's resilience: food, water, energy, health, and ecosystems, supported by cross-sectoral perspectives and disaster risk management enablers. It aligns national policies with subnational implementation instruments and upholds Indonesia's commitments under the Paris Agreement. The document provides baselines and targets for adaptation outcomes, institutionalises monitoring, evaluation, and learning framework consistent with the Enhanced Transparency Framework (ETF), and outlines pathways to mobilize financing, technology, and capacity-building support.

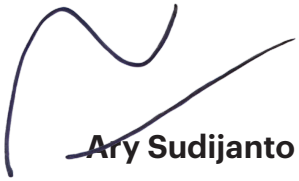
The preparation of this NAP was undertaken from May 2025 to November 2025, fully utilising the nation's institutional, scientific, and participatory capacities. A series of structured national consultations engaged more than 123 institutions and over 400 representatives from national and subnational governments, academia, civil societies, private sector, and development partners. Furthermore, more than 641 written inputs were received through both online and offline channels.

Still, the risks and pressures posed by climate change are accelerating. This reality demands decisive, anticipatory, and coordinated action. Strengthening institutional governance, improving climate information and risk analytics, expanding locally led resilience initiatives, and ensuring stable and innovative financing mechanisms are essential to safeguard

national development achievements and to prevent widening vulnerability gaps. Adaptation is no longer optional. It is an imperative that requires persistent collaboration, shared responsibilities, and sustained leadership at all levels.

I convey my highest acknowledgement and appreciation to all stakeholders who contributed to the formulation of this Plan through analytical inputs, consultations, technical deliberations, and validation processes. Their dedication embodies our shared commitment to protect Indonesia's future. It is expected that the National Adaptation Plan will not only serve as a policy reference, but also as a call to collective action, accelerating the realisation of a climate-resilient, strong, and sustainable Indonesia.

Jakarta, November 2025



Ary Sudijanto

Deputy Minister for Climate Change and Carbon Governance
Ministry of Environment/Environmental Protection Agency
Republic of Indonesia

ABBREVIATIONS AND ACRONYMS

AAL	Average annual loss
ADB	Asian Development Bank
AdCom	*Adaptation Communication*
AKSARA	*Aplikasi Perencanaan-Pemantauan Aksi Pembangunan Rendah Karbon dan Berketahanan Iklim Indonesia* (Indonesia Low-Carbon and Climate Resilience Development Planning and Monitoring Application)
APBD	*Anggaran Pendapatan dan Belanja Daerah* (Regional Budget)
APBN	*Anggaran Pendapatan dan Belanja Negara* (State Budget)
ATR/BPN	*Kementerian Agraria dan Tata Ruang/Badan Pertanahan Nasional* (Ministry of Agrarian Affairs and Spatial Planning/ National Land Agency)
Bakamla	*Badan Keamanan Laut* (Maritime Security Agency)
Bapanas	*Badan Pangan Nasional* (National Food Agency)
Bappenas/ Kemen PPN	*Badan Perencanaan Pembangunan Nasional* (Ministry of National Development Planning)
BBWS	*Balai Besar Wilayah Sungai* (River Basin Authority)
BIG	*Badan Informasi Geospasial* (Geospatial Information Agency)
BMKG	*Badan Meteorologi, Klimatologi, dan Geofisika* (Meteorology, Climatology, and Geophysics Agency)
BNPB	*Badan Nasional Penanggulangan Bencana* (National Disaster Management Agency)
BPBD	*Badan Penanggulangan Bencana Daerah* (Regional Disaster Management Agency)
BPS	*Badan Pusat Statistik* (BPS Statistics Indonesia)
BRGM	*Badan Restorasi Gambut dan Mangrove* (Peatland and Mangrove Restoration Agency)
BRIN	*Badan Riset dan Inovasi Nasional* (National Research and Innovation Agency)
BTR	*Biennial Transparency Report*
BULOG	*Badan Urusan Logistik* (State Logistics Agency)
BUMN	*Badan Usaha Milik Negara* (State-owned enterprises)
CBCA	Climate Budget and Climate Change Adaptation
CLAC	Climate Landscape Analysis for Children
CRC	Climate Risk Code

CRD	Climate-resilient development
CSA	Climate-smart agriculture
CSO	Civil society organization
DRM	Disaster risk management
DRR	Disaster risk reduction
EbA	Ecosystem-based Adaptation
ENDC	Enhanced Nationally Determined Contribution
ENSO	El Niño Southern Oscillation
ETF	Enhanced Transparency Framework
EWS	Early warning system
GCF	Green Climate Fund
GDP	Gross domestic product
GEF	Global Environment Facility
GGA	Global Goal on Adaptation
GHG	Greenhouse gases
GRB	Gender-responsive budgeting
IDG	*Indeks Pembangunan Gender* (Gender Development Index)
IDR	Indonesian rupiah
InaRisk	Indonesia Disaster Risk Information System
InaTEWS	*Indonesia Tsunami Early Warning System*
IPG	*Indeks Pemberdayaan Gender* (Gender Empowerment Index)
IPCC	Intergovernmental Panel on Climate Change
Kemen ESDM	*Kementerian Energi dan Sumber Daya Mineral* (Ministry of Energy and Mineral Resources)
Kemen PR	*Kementerian Perumahan dan Kawasan Permukiman* (Ministry of Housing and Settlements)
Kemen PU	*Kementerian Pekerjaan Umum* (Ministry of Public Works)
Kemen UMKM	*Kementerian Usaha Mikro, Kecil, dan Menengah* (Ministry of Micro, Small, and Medium Enterprises)
Kemendag	*Kementerian Perdagangan* (Ministry of Trade)
Kemnaker	*Kementerian Ketenagakerjaan* (Ministry of Manpower)
Kemendagri	*Kementerian Dalam Negeri* (Ministry of Home Affairs)
Kemendikdasmen	*Kementerian Pendidikan Dasar dan Menengah* (Ministry of Primary and Secondary Education)
Kemendiktisaintek	*Kementerian Pendidikan Tinggi dan Sains-Teknologi* (Ministry of Higher Education and Science and Technology)

Kemenhub	*Kementerian Perhubungan* (Ministry of Transportation)
Kemenhut	*Kementerian Kehutanan* (Ministry of Forestry)
Kemenkeu	*Kementerian Keuangan* (Ministry of Finance)
Kemenkes	*Kementerian Kesehatan* (Ministry of Health)
Kemenko Perekonomian	*Kementerian Koordinator Bidang Perekonomian* (Coordinating Ministry for Economic Affairs)
Kemenkoinfrawil	*Kementerian Koordinator Bidang Infrastruktur dan Wilayah* (Coordinating Ministry for Infrastructure and Regional Affairs)
KemenPPPA	*Kementerian Pemberdayaan Perempuan dan Perlindungan Anak* (Ministry of Women's Empowerment and Child Protection)
Kemensos	*Kementerian Sosial* (Ministry of Social Affairs)
Kementan	*Kementerian Pertanian* (Ministry of Agriculture)
Kemenperin	*Kementerian Perindustrian* (Ministry of Industry)
Kemenko Pangan	*Kementerian Koordinator Bidang Pangan* (Coordinating Ministry for Food Affairs)
KKP	*Kementerian Kelautan dan Perikanan* (Ministry of Marine Affairs and Fisheries)
KLH/BPLH	*Kementerian Lingkungan Hidup/Badan Pengendalian Lingkungan Hidup* (Ministry of Environment/ Environmental Protection Agency)
KLHK	*Kementerian Lingkungan Hidup dan Kehutanan* (Ministry of Environment and Forestry, pre-2024 split)
LTS-LCCR	Long-Term Strategy for Low Carbon and Climate Resilience
MEL	Monitoring, evaluation and learning
MHEWS	Multy Hazard Early Warning System
MoE/EPA	Ministry of Environment/ Environment Protection Agency
MoEF	Ministry of Environment and Forestry (pre-2024 usage in global reporting)
MoF	Ministry of Finance
MoH	Ministry of Health
NAP	National Adaptation Plan
NDC	Nationally Determined Contribution
NEK	*Nilai Ekonomi Karbon* (Carbon Pricing) - Indonesia Spesific
NGO	Non governmental organization
OECD	Organisation for Economic Co-operation and Development
OJK	*Otoritas Jasa Keuangan* (Financial Services Authority)

Posyandu	*Pos Pelayanan Terpadu* (Community maternity clinic)
PBI	*Pembangunan Berketahanan Iklim* (Climate Resilience Development)
PDAM	*Perusahaan Daerah Air Minum* (Regional Drinking Water Company)
Perum Bulog	*State Logistics Agency*
Perpres	*Peraturan Presiden* (Presidential regulation)
PES	Payment for ecosystem services
PPP	Public private partnership
ProKlim	Program Komunitas Iklim (Climate Community Programme)
RAAPID	*Rencana Aksi Adaptasi Perubahan Iklim Daerah* (Regional Climate Change Adaptation Action Plan)
RAD-API	*Rencana Aksi Daerah untuk Adaptasi Perubahan Iklim* (Regional Action Plan for Climate Change Adaptation)
RAN-GPI	*Rencana Aksi Nasional Gender dan Perubahan Iklim* (National Action Plan on Gender and Climate Change)
Renja	*Rencana Kerja* (Work Plan) – for regional government institutions
Renstra	*Rencana Strategis* (Strategic Plan)
RKP	*Rencana Kerja Pemerintah* (Government Work Plan)
RPJMN	*Rencana Pembangunan Jangka Menengah Nasional* (National Medium-Term Development Plan)
RPJPN	*Rencana Pembangunan Jangka Panjang Nasional* (National Long-Term Development Plan)
PLN	*Perusahaan Listrik Negara* (State Electricity Company)
SDGs	Sustainable Development Goals
SFDRR	Sendai Framework for Disaster Risk Reduction
SIDIK	*Sistem Informasi Data Indeks Kerentanan* (Vulnerability Index Data Information System)
SRN-PPI	*Sistem Registri Nasional – Pengendalian Perubahan Iklim* (National Registry System for Climate Change)
UHI	Urban heat island
UNCBD	United Nations Convention on Biological Diversity
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change

GLOSSARY

Adaptation (to climate change)	In human systems - the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities. In natural systems - the process of adjustment to actual climate and its effects; human intervention may facilitate adjustment to expected climate and its effects (IPCC 2022). In Indonesia's NAP, adaptation actions are prioritised by hazard, risk, and alignment with national plans.
Adaptation Communication (AdCom)	Indonesia's formal submission to the UNFCCC (2022) outlining adaptation contexts, priorities, needs, and support. Anchors national direction and transparency alongside the ETF/BTR.
Adaptation co-benefits	Positive effects that a policy or measure aimed at one objective has on another objective, thereby increasing the total benefit to society or the environment. Co-benefits are also referred to as ancillary benefits. In terms of adaptation, these refer to positive secondary outcomes of adaptation actions, such as poverty reduction, biodiversity gains and gender equity.
Adaptation pathway	A series of adaptation choices involving trade-offs between short-term and long-term goals and values. These are processes of deliberation to identify solutions that are meaningful to people in the context of their daily lives and to avoid potential maladaptation.
Adaptive capacity	The ability of systems, institutions, humans and other organisms to adjust to potential damage, to take advantage of opportunities or to respond to consequences.
Adaptive management	A process of iteratively planning, implementing and modifying strategies for managing resources in the face of uncertainty and change. Adaptive management involves adjusting approaches in response to observations of their effect on, and changes in, the system brought on by resulting feedback effects and other variables.
Baseline (climate/ socio-economic)	A time period against which differences are calculated (e.g., expressed as anomalies relative to a baseline). This document used a 1990- 2020 baseline period.

Blue carbon	Biologically driven carbon fluxes and storage in marine systems that are amenable to management. Coastal blue carbon focuses on rooted vegetation in the coastal zone, such as tidal marshes, mangroves and seagrasses. These ecosystems have high carbon burial rates on a per unit area basis and accumulate carbon in their soils and sediments. They provide many non-climatic benefits and can contribute to ecosystem-based adaptation. If degraded or lost, coastal blue carbon ecosystems are likely to release most of their carbon back to the atmosphere. There is current debate regarding the application of the blue carbon concept to other coastal and non-coastal processes and ecosystems, including the open ocean.
Climate budget tagging (Indonesia-specific)	The process of identifying the amount of the public budget used to finance specific output aimed at climate change mitigation and adaptation
Climate hazard	The potential occurrence of a natural or human-induced physical event or trend that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems and environmental resources. In terms of climate events or trends, these include heat stress, droughts, floods and storm surges.
Climate-smart agriculture (CSA)	An approach to agriculture that aims to transform and reorient agricultural systems to effectively support development and ensure food security in a changing climate by sustainably increasing agricultural productivity and incomes, adapting and building resilience to climate change, and reducing and/or removing greenhouse gas emissions, where possible
Climate Risk	The potential for adverse consequences for human or ecological systems, recognising the diversity of values and objectives associated with such systems. In the context of climate change, risks can arise from potential impacts of climate change as well as human responses to climate change. Relevant adverse consequences include those on lives, livelihoods, health and wellbeing, economic, social and cultural assets and investments, infrastructure, services (including ecosystem services), ecosystems and species.

Disaster risk management (DRM)	Processes for designing, implementing and evaluating strategies, policies and measures to improve the understanding of current and future disaster risk, foster disaster risk reduction and transfer, and promote continuous improvement in disaster preparedness, prevention and protection, response and recovery practices, with the explicit purpose of increasing human security, wellbeing, quality of life and sustainable development.
Disaster risk reduction (DRR)	Denotes both a policy goal or objective, and the strategic and instrumental measures employed for anticipating future disaster risk; reducing existing exposure, hazard, or vulnerability; and improving resilience.
Drought	An exceptional period of water shortage for existing ecosystems and the human population (due to low rainfall, high temperature and/or wind). In Indonesia, linked to monsoon cycles or impact of El Niño events on agricultural or water sources.
Ecosystem-based adaptation (EbA)	The use of biodiversity and ecosystem services as part of an overall adaptation strategy to help people to adapt to the adverse effects of climate change. It aims to maintain and increase the resilience and reduce the vulnerability of ecosystems and people in the face of the adverse effects of climate change
Early warning systems (EWS)	The set of technical and institutional capacities to forecast, predict and communicate timely and meaningful warning information to enable individuals, communities, managed ecosystems and organisations threatened by a hazard to prepare to act promptly and appropriately to reduce the possibility of harm or loss. Depending upon context, EWS may draw upon scientific and/or Indigenous knowledge, and other knowledge types. EWS are also considered for ecological applications, e.g. conservation, where the organisation itself is not threatened by hazard, but the ecosystem under conservation is (e.g., coral bleaching alerts), in agriculture (e.g. heavy rainfall, drought, ground frost and hailstorms warnings) and in fisheries (e.g. storm, storm surge, and tsunamis warnings). In Indonesia, these are supported by BMKG and BNPB.
Enhanced Transparency Framework (ETF)	Global reporting system under the Paris Agreement requiring countries to submit adaptation and mitigation information via BTRs.

Equity	The principle of being fair and impartial, and a basis for understanding how the impacts and responses to climate change, including costs and benefits, are distributed in and by society in more or less equal ways. Often aligned with ideas of equality, fairness and justice and applied with respect to equity in the responsibility for, and distribution of, climate impacts and policies across society, generations and gender, and in the sense of who participates and controls the processes of decision-making.
Flood	The overflowing of the normal confines of a stream or other water body, or the accumulation of water over areas that are not normally submerged. Floods can be caused by unusually heavy rain, for example, during storms and cyclones. Floods include river (fluvial) floods, flash floods, urban floods, rain (pluvial) floods, sewer floods, coastal floods and glacial lake outburst floods (GLOFs). Floods in Indonesia are caused by fluvial, flash floods, rain (pluvial) and coastal floods. They are a priority hazard in Indonesia.
Food security	A situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life. The four pillars of food security are: access; availability; stability; and utilisation. The nutritional dimension is integral to the concept of food security.
Gender and vulnerable groups	Communities whose characteristics and conditions pose a high risk of experiencing obstacles in accessing public services, whether physical, social, economic, environmental or geographical. Mainstreamed by KemenPPPA, RAN GPI 2024–2030, and CLAC.
Gender-responsive budgeting (GRB)	The process of tagging activity outputs/sub-outputs in Ministry/Institution Work Plan (Renja K/L) document as a form of the ministry/institution's commitment to supporting gender mainstreaming in development.
Global Goal on Adaptation (GGA)	Global objective under the Paris Agreement enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change with a view to contributing to sustainable development and ensuring an adequate adaptation response in the context of the temperature goal.
Green bonds/ Blue bonds	Financial instruments to mobilise climate and environmental finance for land (green) or marine (blue) systems.

Heat stress	A range of conditions in, for example, terrestrial or aquatic organisms when the body absorbs excess heat during overexposure to high air or water temperatures or thermal radiation. In aquatic water-breathing animals, hypoxia and acidification can exacerbate vulnerability to heat. Heat stress in mammals (including humans) and birds, both in air, is exacerbated by a detrimental combination of ambient heat, high humidity and low wind speeds, causing regulation of body temperature to fail.
Hybrid coastal protection	The combination of engineered structures and ecosystem solutions to reduce coastal risks.
InaRisk (Indonesia-specific)	BNPB's risk information system mapping multi-hazard risks, used in climate adaptation planning.
Mainstreaming (adaptation mainstreaming)	The iterative process of integrating adaptation considerations into policy-making, budgeting and implementation processes at national, sector and subnational levels. It is a multi-year, multi-stakeholder effort that entails working with government actors (head of state's office, environment, finance and planning bodies, sector and subnational bodies, political parties and parliament, national statistics office and judicial system), non-governmental actors (civil society, academia, business and industry, general public and communities, and the media) and development actors.
Maladaptation	Actions that may lead to increased risk of adverse climate-related outcomes, including via increased greenhouse gas (GHG) emissions, increased or shifted vulnerability to climate change, more inequitable outcomes, or diminished welfare, now or in the future. Most often, maladaptation is an unintended consequence.
Malnutrition	Malnutrition encompasses undernutrition (stunting, wasting), but also micronutrient deficiencies, overweight/obesity, and related non-communicable diseases (NCDs)
Monitoring and Evaluation	Mechanisms put in place to respectively monitor and evaluate efforts to reduce greenhouse gas emissions and/or adapt to the impacts of climate change with the aim of systematically identifying, characterising and assessing progress over time. In Indonesia terms, this is a framework for assessing adaptation effectiveness, aligned with ETF, CRC, and RPJMN targets.

NEK (Indonesia-specific)	The value of each unit of greenhouse gas emissions resulting from human and economic activities. In Indonesia, this is regulated under Perpres No 110/2025 and is linked to adaptation co-benefits.
Nexus approaches	Integrated frameworks linking food, water, energy, and ecosystems in adaptation.
ProKlim (Indonesia-specific)	A national-scale programme managed by the Ministry of Environment and Forestry (Now Ministry of Environment/ Environment Protection Agency) to increase community and other stakeholder involvement in strengthening adaptive capacity to the impacts of climate change and reducing greenhouse gas emissions, as well as recognizing climate change adaptation and mitigation efforts that have been implemented to improve welfare at the local level, tailored to regional conditions.
Resilience (climate resilience)	The capacity of interconnected social, economic and ecological systems to cope with a hazardous event, trend or disturbance, responding or reorganising in ways that maintain their essential function, identity and structure. Resilience is a positive attribute when it maintains capacity for adaptation, learning and/or transformation
Resilience pillars (Indonesia-specific)	The Indonesian vision for climate change adaptation included three pillars: economic resilience, social and livelihoods resilience, and ecosystems resilience.
Risk assessment (RA)	The qualitative and/or quantitative scientific estimation of risks.
Risk management	Plans, actions, strategies or policies to reduce the likelihood and/or magnitude of adverse potential consequences, based on assessed or perceived risks.

TABLE OF CONTENTS

Mangrove ecosystem along the coast of Konawe, Kendari © Ika R Suratno, GIZ, 2025

1

INTRODUCTION

1.1 Background and Objectives of the NAP

Climate change is a global challenge with profound national consequences. The Cancun Adaptation Framework (UNFCCC, 2010) first established adaptation as a central priority of the UNFCCC. This was operationalised through Decision 5/CP.17 (UNFCCC, 2011), which introduced National Adaptation Plans (NAPs) as instruments for identifying medium- and long-term adaptation needs. The Paris Agreement (2015) elevated this agenda, setting the Global Goal on Adaptation (GGA) (Article 7) and requiring transparency of adaptation efforts through the Enhanced Transparency Framework (ETF) (Article 13) (UNFCCC, 2015). These provisions made adaptation both a legal obligation and a measurable commitment. More recently, the Glasgow–Sharm el-Sheikh work programme on the GGA (2021–2023) (UNFCCC, 2021) and the UAE Framework for Global Climate Resilience (2023) reaffirmed the centrality of NAPs as vehicles for operationalising the GGA. Parallel negotiations on the Loss and Damage Fund (COP 27, 2022) also emphasise the importance of anticipatory adaptation to reduce residual risks (Brown, 2025).

Indonesia has translated these global mandates into a binding legal framework. The Paris Agreement was ratified through Law No. 16/2016, which commits the country to both mitigation and adaptation. This is reinforced by Law No. 32/2009 on Environmental Protection and Management, which provides the overarching legal basis for resilience and sustainability. Presidential Regulation No. 110/2025 on Carbon Governance dedicates an entire section to adaptation (Articles 35–54), mandating action in food, water, energy, health, and ecosystems. To operationalise these commitments, the Ministerial Regulation No. 12/2024 requires line ministries and sub-national governments to prepare adaptation baselines, targets, and action plans, while also establishing a monitoring, evaluation and learning (MEL) system on Adaptation (Articles 93–99) to ensure transparency and accountability. Collectively, these instruments embed adaptation into both national and local governance structures.

At the international level, Indonesia has submitted key documents that reinforce its adaptation agenda. The Enhanced Nationally Determined Contribution (ENDC) includes a dedicated adaptation annex (Government of Indonesia, 2022a), the Adaptation Communication (2022) details national priorities and support needs (Government of Indonesia, 2022b), and the Biennial Transparency Report (2024) provides a progress assessment consistent with the ETF (Government of Indonesia, 2024a). These submissions highlight Indonesia's transparency and accountability while underscoring the need for a single, consolidated framework that integrates and prioritises adaptation action. Indonesia's NAP fulfils this role by aligning fragmented submissions into a coherent strategy.

Adaptation is also central to Indonesia's development vision. The National Medium-Term Development Plan (RPJMN) 2025–2029 emphasises inclusive growth, human capital development, and ecological resilience (Bappenas, 2025b), while the National Long-Term Development Plan (RPJPN) 2025–2045 outlines the Indonesia Emas 2045 vision of Indonesia as a sovereign, advanced and sustainable nation (Bappenas, 2025c). Climate risks such as drought, flooding and disease outbreaks pose systemic threats to these ambitions. The Indonesian Biodiversity Strategy and Action Plan (IBSAP 2025–2045) further emphasises that ecosystem resilience is essential for sustaining long-term development, as outlined in Goal 1.6 (Mitigation and Adaptation to Climate Change) (Bappenas, 2025a). Adaptation, therefore, is not a stand-alone agenda but a safeguard for national prosperity.

As illustrated in Figure 1.1, Indonesia's NAP is situated at the intersection of global adaptation mandates, national legal frameworks, and development planning priorities, providing the structural basis for integrating climate resilience into long-term national development. Within this framework, Indonesia's NAP pursues three overarching objectives (Government of Indonesia, 2022a; Bappenas, 2021, KLHK, 2020):

1. Provide a science-based foundation for identifying climate impacts, vulnerabilities, and risks in line with national priorities and UNFCCC guidance.
2. Mainstream adaptation into national and subnational development planning, ensuring coherence with the RPJMN 2025–2029, RPJPN 2025–2045, and sectoral strategies, while contributing to the GGA.
3. Operationalise, monitor, and evaluate adaptation actions, based on ENDC Annex 2 and consistent with Presidential Decree 110/2025, MoEF Regulation 12/2024, and the ETF, thereby ensuring accountability and measurable progress.

These objectives position the NAP as both a national policy anchor and a global contribution instrument. It consolidates legal mandates, aligns adaptation with development priorities, and bridges Indonesia's domestic responsibilities with its international obligations.

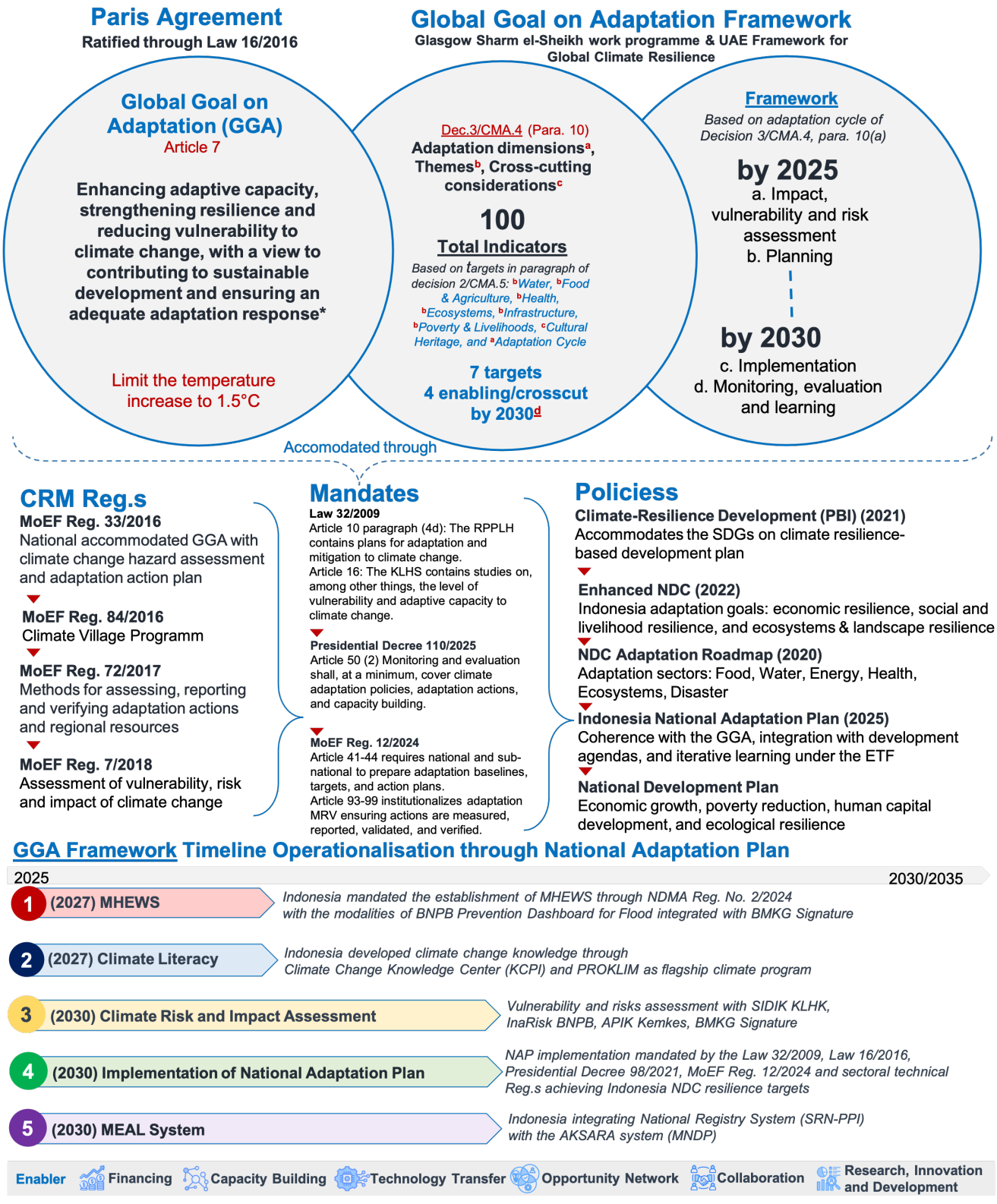


Figure 1.1 Global to national framework on adaptation. Linking Paris Agreement, national laws (Law 16/2016, Law 32/2009, Presidential Decree 110/2025, MoEF Regulation 12/2024), and development goals.

1.2 Rationale for Adaptation in Indonesia

Indonesia's rationale for formulating a National Adaptation Plan (NAP) is grounded in evidence that climate change poses a direct threat to national development, with measurable economic impacts and clear consequences for social and ecological systems. Adaptation is not an optional supplement to development planning but an essential safeguard for achieving Indonesia's long-term vision of sustainable prosperity.

1.2.1 Economic and Sectoral Consequences of Climate Change

The rationale for adaptation in Indonesia is grounded in robust evidence that climate change poses direct economic and sectoral risks. At the macroeconomic level, the NDC Adaptation Roadmap (KLHK, 2020), projected significant reductions in GDP growth by 2050 if climate risks remain unmanaged. The Long-Term Strategy for Low Carbon ad Climate Resilience (LTS-LCCR (Government of Indonesia, 2021) reaffirmed that cumulative damages would erode economic stability, while the Climate-Resilience Development policy (PBI) (Bappenas, 2021) stressed that development gains are unsustainable without adaptation. Together, these studies highlight that adaptation is not a cost but an investment in safeguarding GDP, employment, and fiscal stability.

Climate change undermines sectoral systems that are central to Indonesia's development.

- In food systems, rice yields in major producing provinces are projected to decline by up to 11% by 2050 without adaptation (Government of Indonesia, 2022a; KLHK, 2020). Plantation crops such as cocoa and coffee face declining suitability in Sumatra and Kalimantan, while fisheries and aquaculture are threatened by ocean warming and acidification, which reduce productivity and disrupt livelihoods, particularly in eastern Indonesia (Government of Indonesia, 2022b).
- In water systems, recurrent droughts in provinces such as East Nusa Tenggara reduce irrigation potential and drinking water availability, while extreme rainfall events damage infrastructure and increase flood risks (Bappenas, 2021). This dual threat of scarcity and excess creates systemic challenges for agriculture, hydropower, and urban water supply (Bappenas, 2021). Water scarcity and excess together jeopardize development targets related to infrastructure reliability, industrial competitiveness, and household wellbeing (Khalil et al., 2021).
- In energy systems, rainfall variability disrupts hydropower generation, while sea level rise and storm surges threaten coastal energy infrastructure (Setiawan et al., 2025; Government of Indonesia, 2021). As Indonesia transitions to renewable energy under the RPJMN 2025–2029, adaptation is critical to ensuring that energy systems remain resilient.

- In health systems, urban heat islands in cities such as Jakarta and Surabaya exacerbate heat stress, while vector-borne diseases such as dengue and malaria expand in range and seasonality (Government of Indonesia, 2024a; Khairunnisa et al., 2023; Muzaky and Jaelani, 2019; and Siswanto et al., 2023;). These trends increase healthcare costs and reduce labor productivity, undermining human capital formation.
- In ecosystems, mangroves, peatlands, and coral reefs provide essential services such as fisheries productivity, carbon sequestration, and coastal protection. Climate change accelerates their degradation through bleaching, fires, and deforestation, eroding both ecological stability and local livelihoods (KLHK, 2020).
- Disaster risk management (DRM) cuts across all these systems. Climate-related disasters account for over 99% of recorded events in Indonesia (BNPB, 2025), with annual economic losses estimated at over 6% of GDP (Government of Indonesia, 2022b). DRM is therefore best understood not as a separate sector but as an enabling system that integrates food, water, energy, health, and ecosystems. Its role is to reduce residual risks, manage cascading hazards, and strengthen anticipatory capacity.

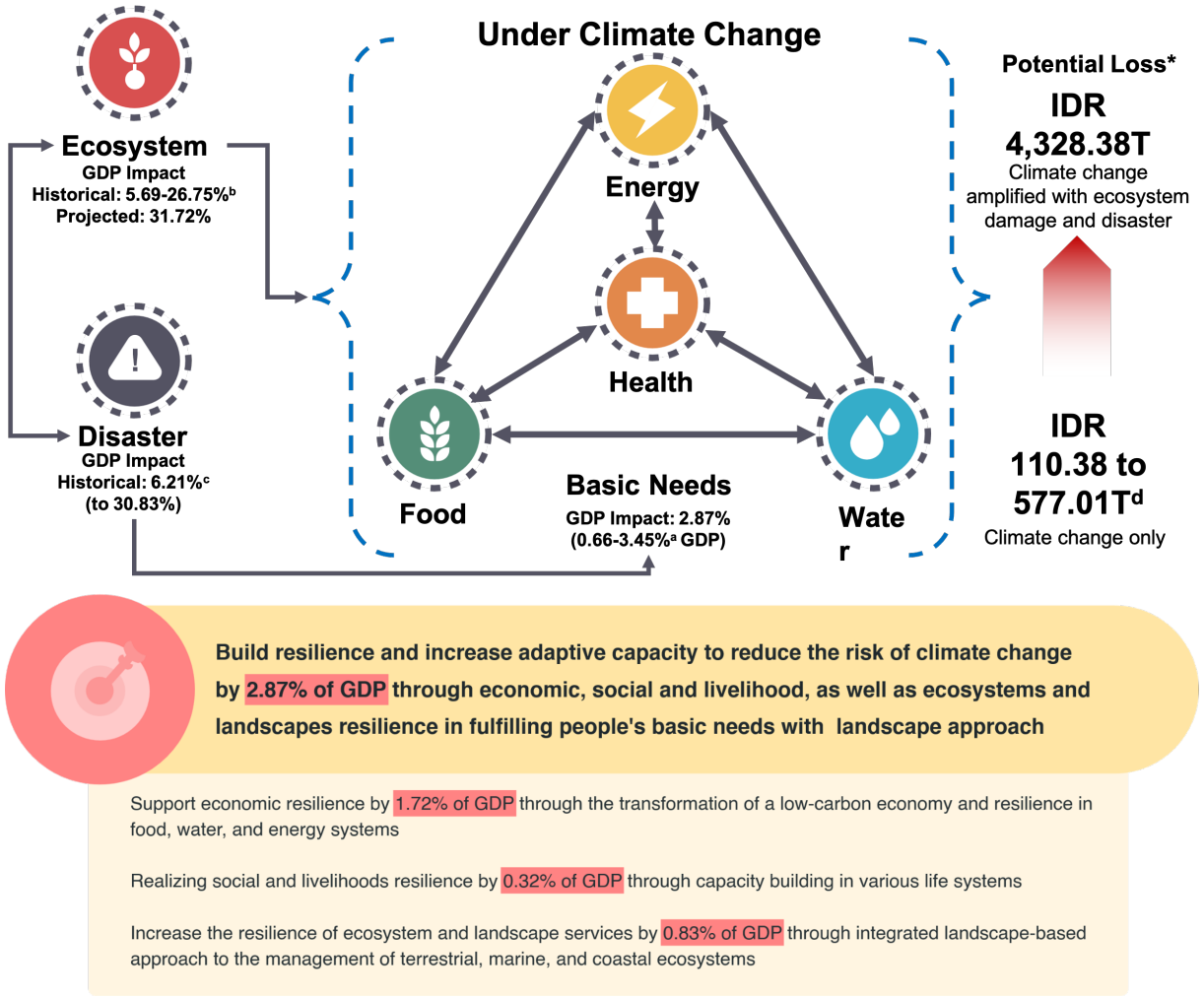


Figure 1.2 Economic consequences of climate change in Indonesia. Projected to 2050 GDP impacts, fiscal burdens and long-term costs under various scenarios. Sources: Bappenas (2021c); Government of Indonesia (2021); KLHK (2020)

The patterns illustrated in Figure 1.2 reveal how climate-related shocks translate into macroeconomic losses through declining agricultural output, infrastructure damage and increased fiscal spending for recovery. These economic disruptions are closely linked with social and ecological systems, where stress in one sector quickly propagates to others. Figure 1.3 therefore extends the analysis by visualising these interdependencies, showing that Indonesia's climate-related economic risks stem from feedback loops among food, water, energy, health and ecosystems. Recognising these connections provides the rationale for adopting a nexus approach and positioning DRM as an enabling system that underpins resilience across all sectors.

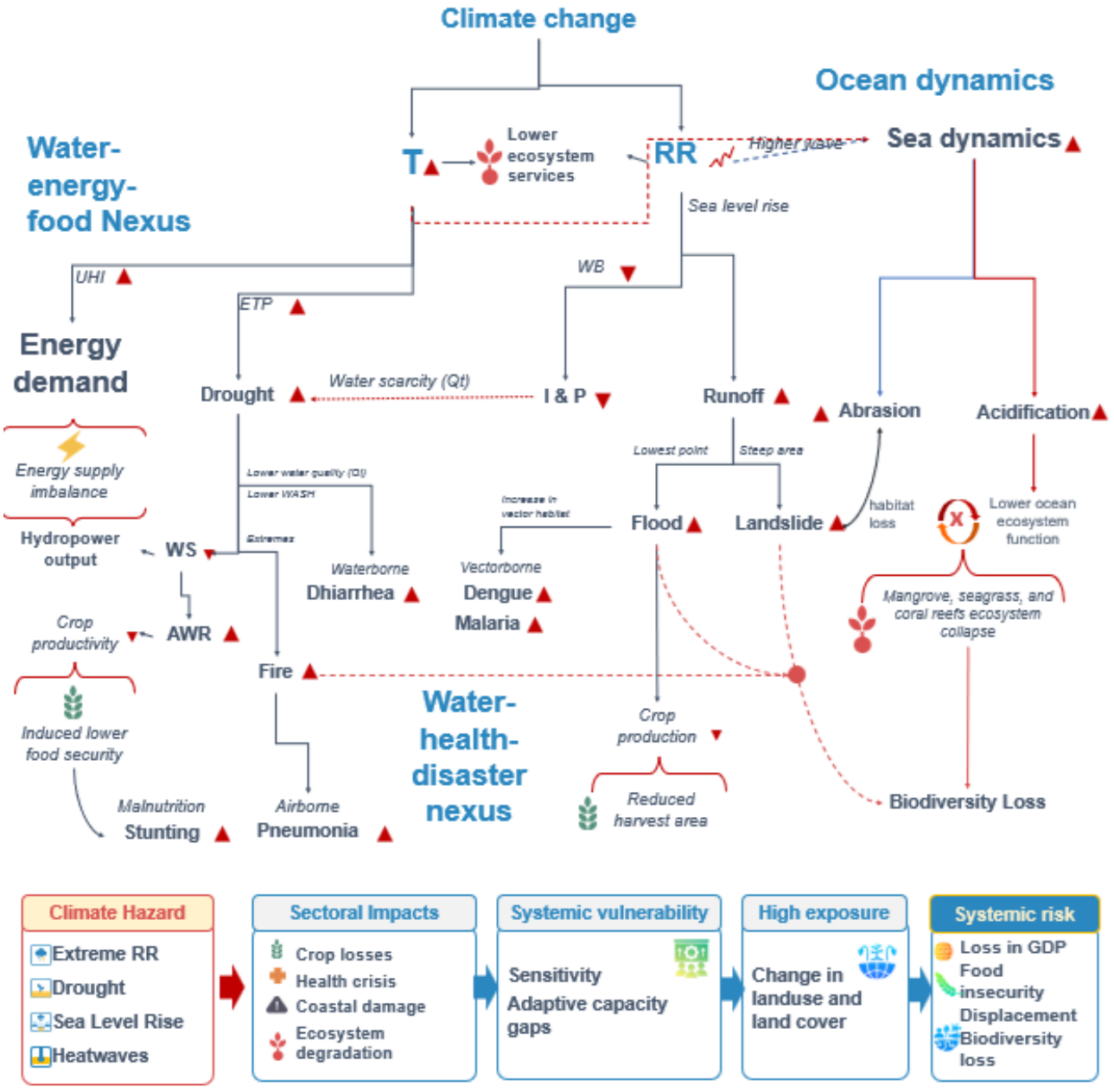


Figure 1.3 Nexus of sectoral risks. Interconnections between food, water, energy, health and ecosystems, with disaster risk management (DRM) as an enabling cross-cutting system. Source: Government of Indonesia (2022b)

1.2.2 National Adaptation Targets and Development Coherence

Indonesia's adaptation targets are anchored in its international submissions and national strategies. The ENDC (Government of Indonesia, 2022a) includes Annex 2 on adaptation priorities, the LTS-LCCR (Government of Indonesia, 2021) outlines long-term adaptation pathways, and the PBI (Bappenas, 2021) emphasises resilience as being essential for development. Together, they establish three overarching resilience pillars:

1. Economic resilience: protecting GDP growth, employment and investment from climate shocks by strengthening climate-resilient agriculture, energy and infrastructure systems.
2. Ecosystem and landscape resilience: safeguarding ecosystems, biodiversity and natural capital to sustain long-term productivity and ecological services.
3. Social and livelihood resilience: securing livelihoods, protecting health and nutrition, and reducing vulnerabilities of women, children, elderly and vulnerable groups.

These pillars are embedded in the RPJMN 2025–2029 and RPJPN 2025–2045, ensuring that adaptation is mainstreamed into the development vision of Indonesia Emas 2045 (Bappenas, 2025c). The IBSAP 2025–2045 further integrates adaptation into biodiversity strategies, reinforcing the role of natural capital (Bappenas, 2025a). As shown in Figure 1.4, the NAP consolidates these targets, ensuring coherence between global obligations, national laws and development agendas, while directly linking to the three resilience priorities that are elaborated in Chapter 6.

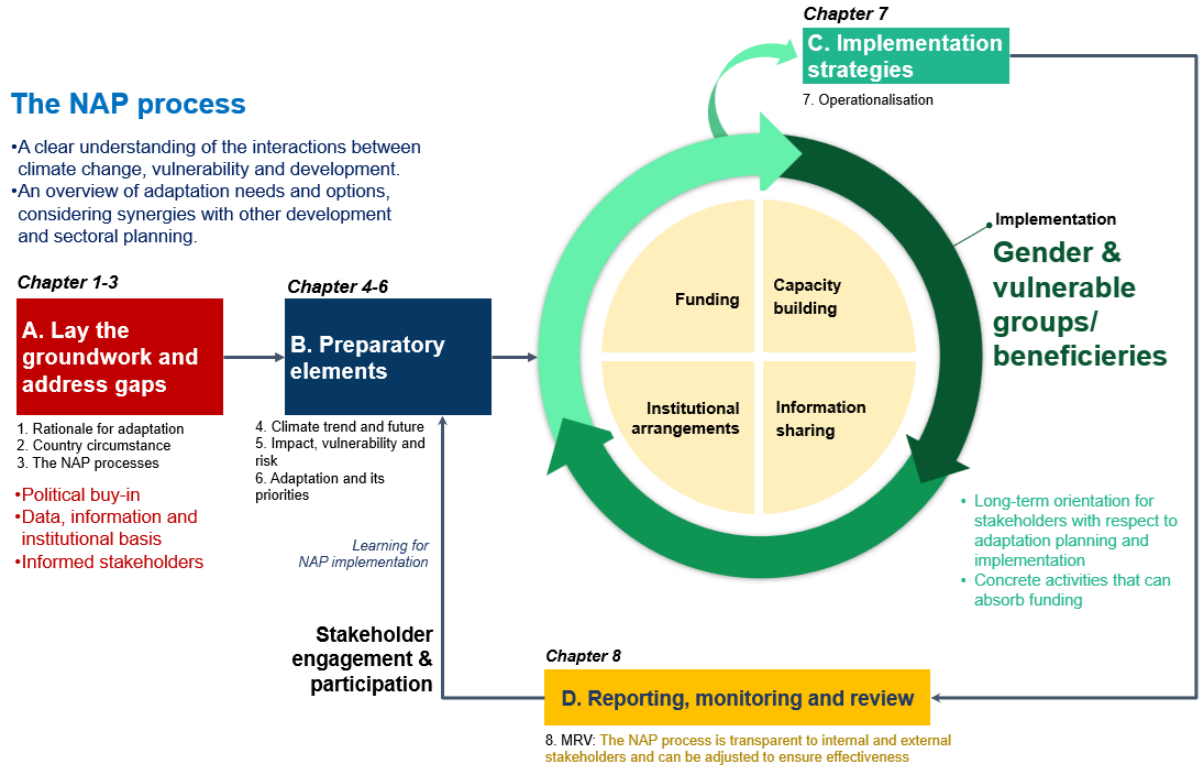


Figure 1.4 National Adaptation Plan (NAP) framework overview: Stages, elements and strategic implementation. The figure summarises the report structure based on NAP elements.

Wakatobi, © UNDP Indonesia, 2025

2

COUNTRY CIRCUMSTANCES

2.1 Overview of Indonesia's Development and Climate Context

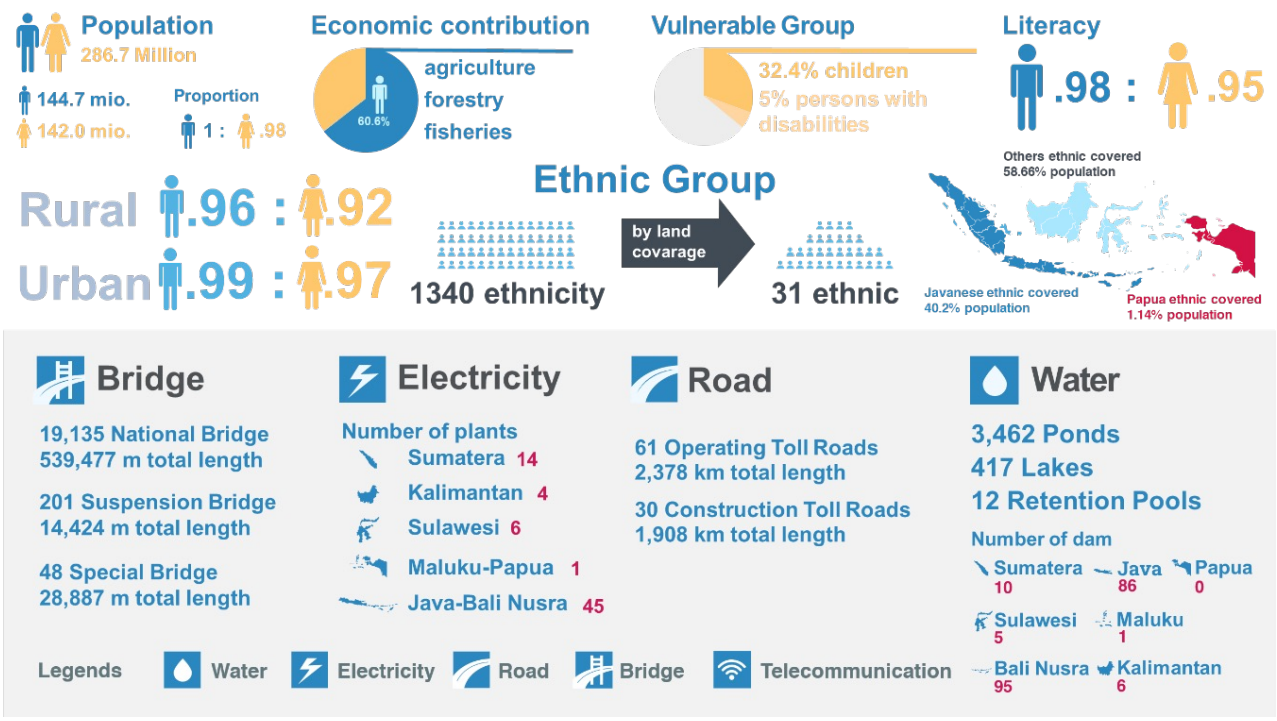
Indonesia's ecosystems form the ecological foundation of national resilience. They regulate water flows, buffer coasts, sustain fisheries, store carbon and support livelihoods. Yet these systems are under growing pressure from climatic hazards (prolonged droughts, extreme rainfall, peatland drying, sea level rise and ocean warming) that increasingly translate into systemic risks for people and the economy. Indonesia's population reached 278.7 million (2023), 281.6 million (2024), and 284.4 million (2025), maintaining its position as the world's fourth most populous nation. Urbanisation is projected to rise from 60% (BPS baseline) to 70% by 2045 (Bappenas, 2025c), heightening exposure to flooding and heat while rural livelihoods remain climate-sensitive. The economy expanded from USD 1.32 trillion in 2022 to USD 1.40 trillion in 2024 (World Bank, 2023; World Bank, 2025). The RPJMN 2025–2029 (Presidential Decree 12/2025) targets 5.6%–6.1% annual growth and poverty reduction of 4.5%–5% by 2029. The RPJPN 2025–2045 (Law 59/2024) envisions Indonesia Emas 2045 – a sovereign, advanced and sustainable nation. These ambitions are climate-sensitive: unmanaged hazards could slow or reverse progress (World Bank, 2023; IPCC, 2022b).

Wakatobi, © UNDP Indonesia, 2025

Table 2.1 Socio economic and climate indicators of Indonesia

Indicator	Current Status	Climate Linkage
Poverty rate	8.47% (BPS, 2025a)	Climate shocks push vulnerable households back into poverty
Informal employment	59,40% (BPS, 2025b)	Informality reduces adaptive capacity and means that social protection mechanisms have limited ability to reach people
Middle class	Shrinking: 23% (2018) to 17.13% (2024) (Suryahadi, 2025)	Climate risks erode income security, limiting upward mobility
Stunting	19,8% (2024) (Kemenkes, 2025c)	Malnutrition worsened by droughts, floods, and food price shocks
Gini index	0.375 (BPS 2025)	Inequality amplifies differential climate vulnerability
Disaster losses	2,2% GDP (GoI 2022)	Fiscal space reduced for adaptation and development (GoI 2022)
CCRI ranking	46th (UNICEF 2021)	High climate risk exposure relative to peers

The NDC Adaptation Roadmap (2020) projects that climate change could reduce GDP growth by 2050 (KLHK, 2020). Agricultural losses are estimated at 10%–17.5% in rice-producing areas of Java and Sumatra (Kemenkeu, 2021; World Bank, 2021). Marine and coastal fisheries may lose 15%–26% of economic returns (World Bank 2024). Health sector losses already exceed IDR 31 trillion (2024), and heat stress could cut 2.2% of global working hours by 2030 (ILO, 2019). Disaster losses average around 0.61% of GDP (around IDR 102 trillion in 2020) (Government of Indonesia, 2022b). These projections were reiterated in the LTS-LCCR and PBI, which warned that cumulative damages from climate change would compromise economic stability, environmental sustainability and social progress if resilience is not systematically mainstreamed.



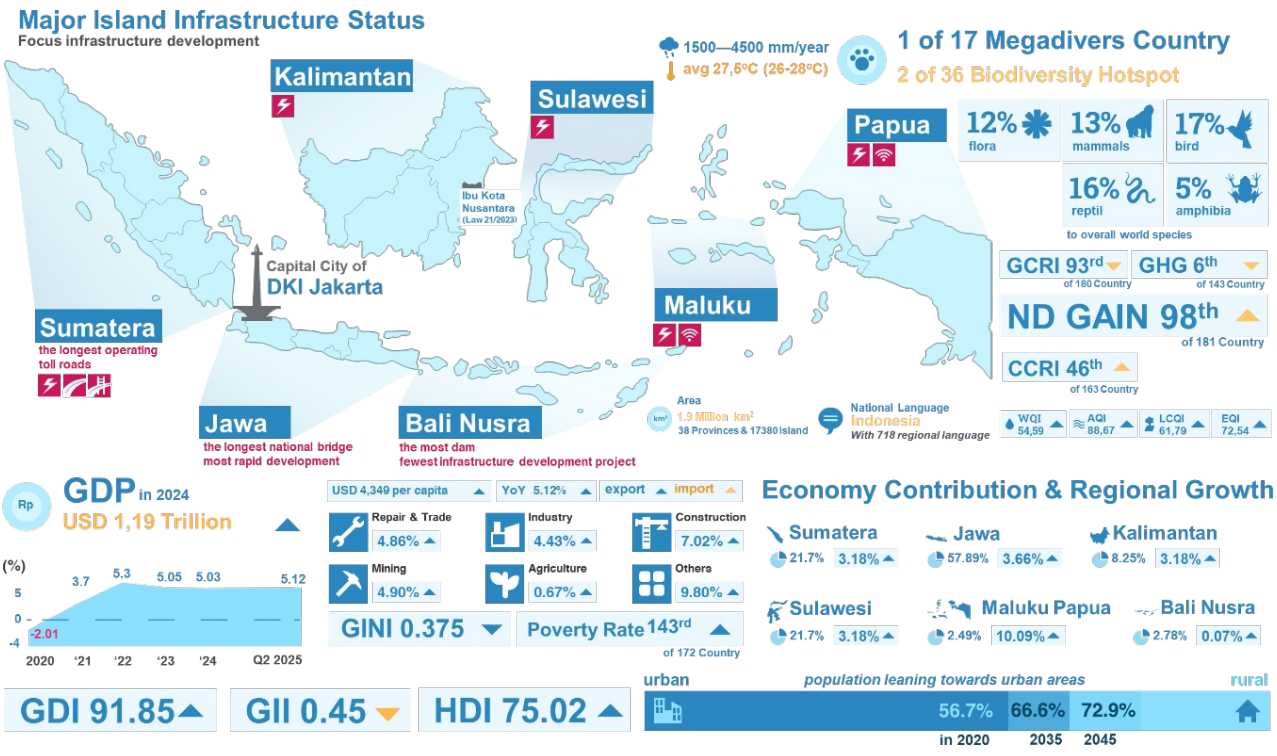


Figure 2.1 (a) Indonesia's socio-economic and development context, demographic, economic, and (b) Ecological indicators reflect progress yet persistent climate vulnerabilities, justify the integration of resilience into national planning. Source: updated from Adcomm (Government of Indonesia, 2022b), updated data and information available in Annex 1. Details: both box provided clear latest (2024 to Q2 2025) quantitative values, data and information.

Box 2.1 – Climate Impacts on Children and Youth

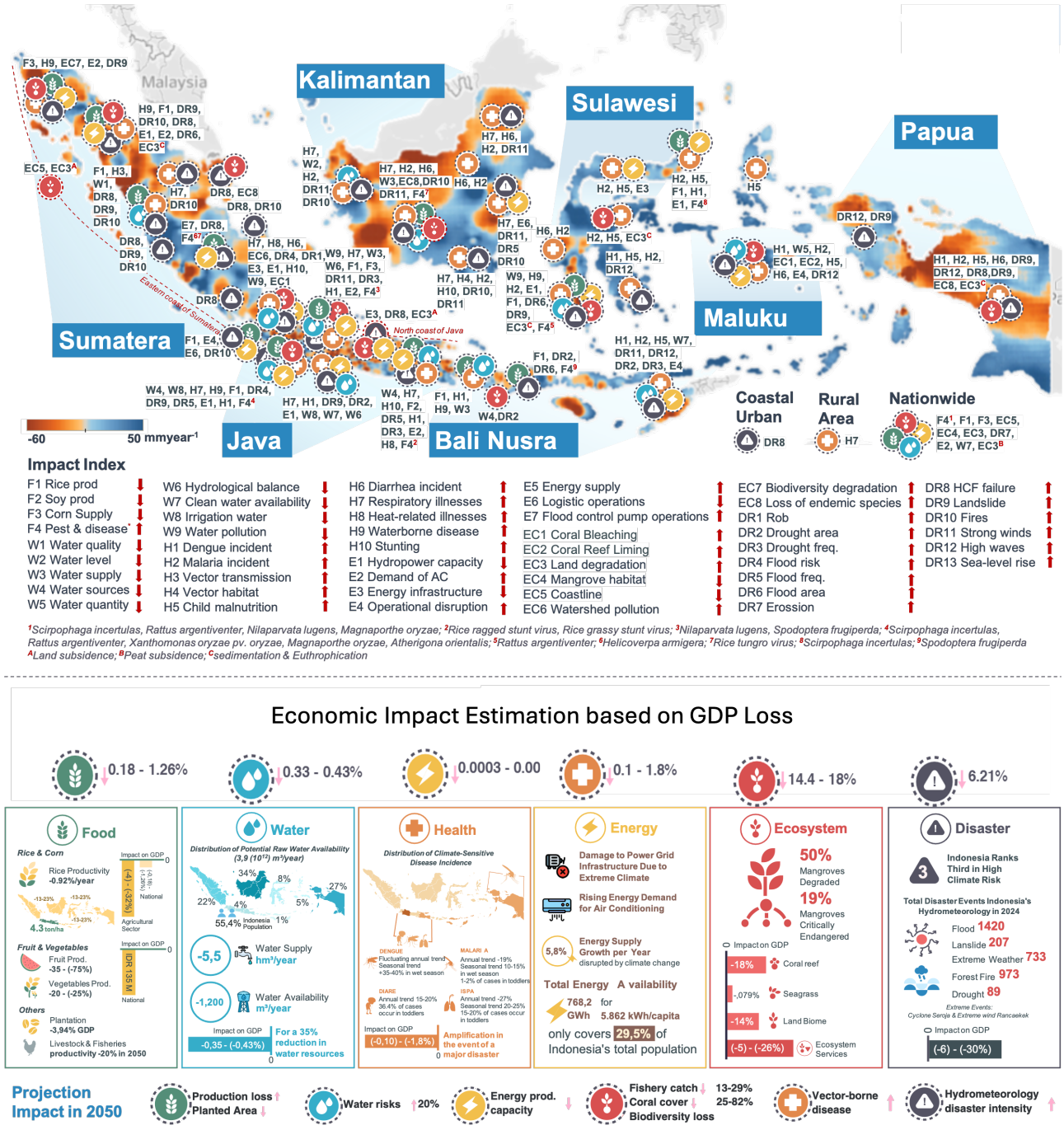
The Climate Landscape Analysis for Children (CLAC) (UNICEF, 2023) adds a human-capital dimension: 28 million children are exposed to coastal flooding, 15 million to heat stress, and 74 million to high air-pollution levels; 21 million live in flood-prone zones. Climate shocks undermine nutrition and schooling in more than 50 000 schools (2009–2018). Protecting youth and children is thus a core adaptation priority.

- **Health burdens:** Climate shocks worsen child nutrition and health: Indonesia's stunting prevalence was 21.6% in 2022 (Kemenkes 2022); floods raise diarrhoeal disease, droughts undermine food security, and haze increases respiratory morbidity; heat and poor air quality also harm child development and cognition (Cissé et al., 2022).
- **Education disruption:** 50,666 schools were affected by climate-related disasters in 2009-2018 (UNICEF, 2023).
- **Social vulnerability:** Poor and rural households reliant on climate-sensitive livelihoods face compounded risks, while urban youth increasingly suffer from heat stress and air pollution, impairing physical and cognitive development (UNICEF, 2023; Birkmann et al., 2022).
- **Intergenerational impacts:** Without action, today's shocks will entrench poverty and inequality, undermining Indonesia's demographic dividend and SDG progress; UNICEF's assessments emphasise children's disproportionate exposure and sensitivity.

NAP relevance: Protecting children and youth is central to Indonesia's adaptation agenda: CLAC (UNICEF, 2023) calls for child-sensitive policies across health, education, WASH (Water, Sanitation and Hygiene) and social protection, and the Government of Indonesia recognizes children as a key vulnerable group supporting their explicit inclusion in NAP design and investment (Government of Indonesia, 2022b).

These risks intersect with national development priorities in critical ways. Food security is jeopardised by declining crop yields and fisheries productivity, undermining efforts to reduce malnutrition and rural poverty. Water stress is a challenge limited to the island groups of Java, Bali, East Nusa Tenggara (NTT) and Sulawesi, whereas Papua, Kalimantan and Sumatra struggle more with access to WASH services (Khalil et al., 2021). Energy security is threatened by rainfall variability that destabilises hydropower and by the vulnerability of coastal energy infrastructure to sea level rise. Public health faces mounting challenges from expanding disease vectors and heat-related illnesses, placing new burdens on health

systems and reducing labor productivity. Ecosystems such as mangroves, peatlands, and coral reefs, vital for biodiversity, carbon sequestration, and disaster protection, are increasingly degraded, with cascading impacts on fisheries, tourism, and livelihoods. Finally, disaster risk management is under strain as annual losses from floods, droughts, and fires escalate into trillions of rupiah, intensifying fiscal pressures and social costs.



[1]Scirpophaga incertulas, Rattus argentiventer, Nilaparvata lugens, Magnaporthe oryzae; [2]Rice ragged stunt virus, Rice grassy stunt virus; [3]Nilaparvata lugens, Spodoptera frugiperda; [4]Scirpophaga incertulas, Rattus argentiventer, Xanthomonas oryzae pv. oryzae, Magnaporthe oryzae, Atherigona orientalis; [5]Rattus argentiventer; [6]Helicoverpa armigera; [7]Rice tungro virus; [8]Scirpophaga incertulas; [9]Spodoptera frugiperda
[A]Land subsidence; [B]Peat subsidence; [C]sedimentation & Euthrophication

Figure 2.2 Spatial distribution of multi-sector climate impacts. The compilation explaines that some areas experience multisectoral climate impacts. The impacts directly contribute to the national GDP loss.

The Adaptation Communication (Government of Indonesia, 2022b) identifies these six sectors food, water, energy, health, ecosystems, and disaster risk management as national adaptation priorities, emphasising their role in safeguarding development goals. The Adaptation Communication further commits Indonesia to enhancing resilience across these areas, aligning with the long-term targets of the RPJMN. Adaptation is therefore not a peripheral concern but central to economic transformation, ecological sustainability, and social wellbeing. By linking adaptation explicitly to national development priorities, Indonesia acknowledges that climate resilience is a prerequisite for achieving its growth and transformation agenda.

Overall, Indonesia's development and climate context illustrates a dynamic tension: ambitious economic and social goals on the one hand, and intensifying climate risks on the other. Quantitative assessments from the NDC Roadmap, LTS-LCCR, PBI, CLAC, and official submissions to the UNFCCC demonstrate the material risks climate change poses to GDP, human development, and ecological resilience. These risks cut across all dimensions of national progress and demand a consolidated strategy. This is the foundation upon which the National Adaptation Plan is built, and the reason why Indonesia must pursue adaptation as a central pillar of its development pathway.

2.2 Climate and Disaster Risk Profile

Indonesia faces escalating climate-related hazards. The National Disaster Management Agency (BNPB) (2025a) recorded 3,472 disasters in 2024: floods (35%), fires (20%), droughts (15%), landslides (10%) and coastal inundation (5%). The Indonesia Disaster Risk Index (IRBI) (2024) classifies eight provinces as high risk and 151 districts (around 29%) as very high risk. The Meteorology, Climatology and Geophysics Agency (BMKG) and Intergovernmental Panel on Climate Change (IPCC) (2022) report rainfall intensity up by 20%–30%, longer dry spells from the El Niño Southern Oscillation (ENSO) and Indian Ocean Dipole (IOD), and sea level rise around 4.3 ± 0.4 mm yr^{-1}. The rate of change in average air temperature in Indonesia during 1981–2024 generally increased by 1.02°C over the 44-year period.

Floods and landslides are the primary cause of losses in Java, Sumatra and Sulawesi, costing around 1%–1.6% of GDP annually (Khalil et al., 2021). Urban flooding in Jakarta, Bandung and Makassar has intensified due to drainage deficits and subsidence. Droughts in East and West Nusa Tenggara provinces (NTT and NTB, respectively) have lowered crop yields and water availability. In 2024, rice production was recorded at 711,726 metric tons of milled dry grain, representing a decline of 55,084 tons (7.18%) compared to 2023 production (766,810 tons), attributable to the 2024 El Niño event (NTT Provincial Agriculture

and Food Security Office, 2025). Peat and forest fires in Sumatra and Kalimantan in 2019 burned around 620,000 hectares (ha) and caused IDR 72.9 trillion in losses (World Bank, 2023; KLHK, 2022). Coastal hazards are worsened by subsidence (1–15 cm yr^{-1} in Jakarta and Semarang), triggering chronic tidal flooding and saline intrusion (Sarah, 2022; KLHK, 2021a). Nearly four million people could be displaced by 2070 if these trends continue. Localised tornadoes in Java and Sulawesi in 2023 and 2024 illustrate emerging extreme weather risks (BNPB, 2025a).

Regional patterns are clear: Java and Bali face flood and water stress; Sumatra and Kalimantan endure flood-fire cycles; Sulawesi and Maluku suffer coastal erosion and storms; NTT and NTB experience chronic drought; and Papua faces landslides and extreme rainfall. Small islands are increasingly exposed to sea level rise and saltwater intrusion. Economic losses average 0.61% of GDP (around IDR 102–115 trillion) (Government of Indonesia, 2022b). Floods and landslides disrupt transport; droughts trigger food price volatility; fires cause acute upper respiratory tract infections and school closures; and coastal floods damage housing and ports. Cumulative losses reduce fiscal space and strain local budgets. BNPB (2025a) notes that women and informal workers are disproportionately affected – reaffirming the National Action Plan on Gender and Climate Change (RAN-GPI)'s emphasis on social inclusion and gender-responsive recovery planning, as described later in Box 2.2.

Disaster risk management (DRM) is governed by Law 24/2007, Government Decree 21/2008, and Presidential Decree 87/2020 on the Disaster Management Masterplan or Rencana Induk Penanggulangan Bencana (RIPB) 2025–2045. BNPB coordinates risk assessment, early warning and emergency response through its regional offices (BPBDs). Multi-hazard early warning systems such as InaTEWS, Sipongi and Flood-EWS operate nationwide, but require improved data interoperability and community outreach. The National Disaster Management Plan (RENAS PB) 2025–2029 integrates DRM within risk-informed national development and links it to SDGs 11 and 13.

Flooding in Simonet Pekalongan©ZCRA,MCI, 2024

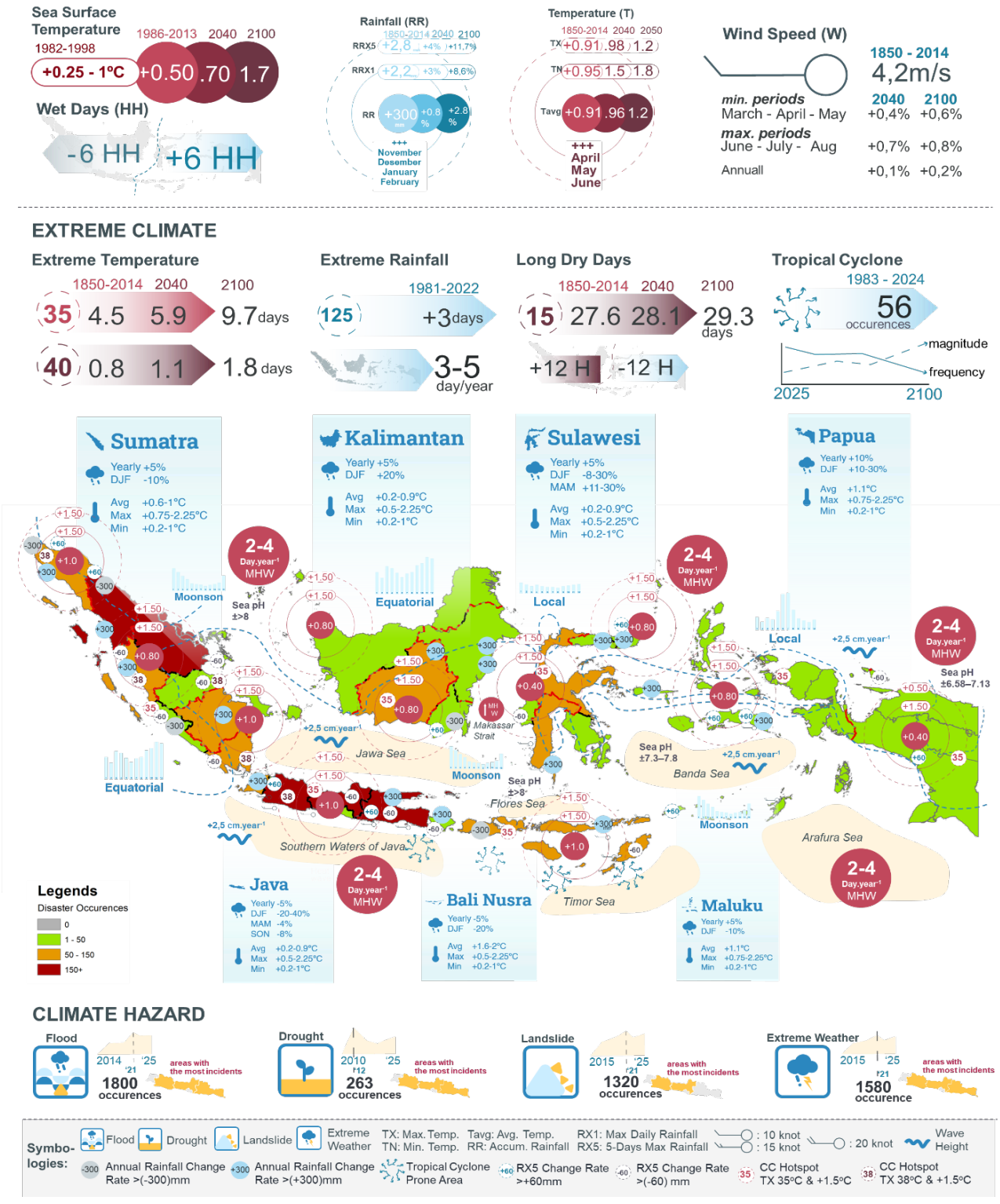


Figure 2.3 Projections of climate change impacts in Indonesia: Extreme climate events, weather patterns, and vulnerability to hazards. Details: TX for maximum temperature and TN for minimum temperature. R represents rainfall projections, covering both daily and cumulative values. Additionally, the figure includes projections for wind speed and tropical cyclones. Icons are used to represent extreme events such as floods, droughts, landslides, and other extreme weather phenomena, with numeric values indicating their occurrences in specific regions.

Financial readiness has advanced through the Pooling Fund for Disasters or Pooling Fund Bencana (PFB), managed by the Ministry of Finance (Kemenkeu), providing pre-arranged resources for rapid recovery. Risk-financing pilots and disaster insurance schemes are expanding under collaboration among Kemenkeu, BNPB, and Ministry of Environment (KLH). DRM actions are recorded in the National Registry System for Climate Change (SRN-PPI) and incorporated into MEL adaptation, strengthening transparency and alignment with the Enhanced Transparency Framework (ETF).

Despite progress, several challenges persist. Inter-agency data exchange between BNPB, BMKG, KLH, and sub-national governments remains uneven, and gender-disaggregated impact data are limited. Community preparedness through the Community Climate Programme (ProKlim) and local early-warning dissemination needs scaling to reach vulnerable islands and remote uplands. IIntegration of datasets across IRBI, SRN and the AKSARA Indonesia Low-Carbon Development Planning and Monitoring Application will be crucial for monitoring loss and damage, and prioritising adaptive investment. Strengthening local analytic capacity to interpret risk information will enhance planning consistency with RPJMN, and RAAPID/ RAD-API regional climate change adaptation plan documents.

Climate-related disasters exacerbate social and spatial inequality. Poor households and female-headed families recover more slowly, while informal workers experience extended income loss. Agricultural stress and coastal inundation drive migration toward hazard-prone urban areas, creating cyclical vulnerability. These dynamics confirm that disaster risk in Indonesia is not merely environmental but structural - rooted in socio-economic exposure, ecological degradation, and governance gaps.

The increasing frequency and intensity of climate extremes now represent structural constraints to national development. Losses from floods, droughts, fires, and coastal hazards directly undermine infrastructure reliability, fiscal stability, and ecosystem services. Integrating risk data into national and regional planning - through RPJMN, RAD-API and RAAPID - supported by MEL Adaptation and fiscal instruments such as the PFB - is essential to sustain economic growth and safeguard livelihoods.

Flooding in Simonet Pekalongan ©ZCRA MCI

2.3 Socio-Economic and Ecological Circumstances

Indonesia's poverty rate declined to 8.57% in September 2024, representing significant gains compared to more than 24% two decades earlier (BPS, 2025c). However, climate shocks continue to threaten this progress, particularly in rural regions dependent on agriculture, forestry, and fisheries, which employ roughly 28,18% of the workforce (BPS, 2024b). Informal employment accounts for 58% of jobs, limiting access to social protection and insurance against shocks (BPS, 2024b). Meanwhile, the middle class has contracted, falling from 23% of the population in 2018 to around 17.13% in 2024 (BPS, 2024b), raising concerns about the sustainability of consumption-driven growth.

The structure of income reflects ongoing transitions in the economy. Agriculture's contribution to GDP has declined, while manufacturing has contracted from 30% of GDP in 2002 to around 18.98% in 2024, reducing the share of formal jobs (BPS, 2025c). Services now dominate, employing more than 45% of the workforce, but large segments are concentrated in informal, low-productivity activities vulnerable to disruptions from floods, heat, and transport failures. This structure leaves household incomes sensitive to climate variability, especially when agriculture yields drop or urban services are interrupted by disasters. Human capital remains vulnerable to climate stresses. Child stunting was reduced from 36,4% in 2013 to 21.6% in 2022, a major achievement (WHO, 2015), but the Climate Landscape Analysis for Children (UNICEF, 2023) warns that climate shocks undermine nutrition, health, and education outcomes.

Indonesia's fiscal landscape underscores the scale of climate pressures. Indonesia's NDC roadmap projects climate-related disasters, including ecosystem damage across food, water, energy, and health, could cost up to IDR 4,328.38 trillion by 2030. Climate and disaster-related losses in priority sectors already exceed IDR 100 trillion per year, reaching IDR 102.36 trillion in 2020 and IDR 115.53 trillion in 2024 (Government of Indonesia, 2022b). Climate change also has direct implications for labour productivity and capital flows. Labour productivity is estimated to decline by 2%-3% for each 1°C increase in ambient temperature above 20°C (WHO and WMO, 2025). Over 2.4 billion workers face the threat of heat stress, particularly in developing nations.

Pura Ulun Danu Bali ©Widhi, MoE/EPA, 2025

Box 2.2 – Gender and Vulnerable Groups in the Context of Climate Change

Women, the elderly, persons with disabilities, and informal-sector workers experience disproportionate climate impacts due to limited access to resources and decision-making. The National Action Plan on Gender and Climate Change (RAN-GPI 2024–2030), developed by the Ministry of Women's Empowerment and Child Protection (KPPPA) and the Ministry of Environment (KLH), mainstreams gender equality and social inclusion across seven climate-relevant sectors: agriculture and water, ecosystems, energy and waste, industry and innovation, disaster resilience, health and social protection, and the blue economy.

Women constitute a large share of the informal workforce and face persistent gaps in access to finance and digital technologies (UN Women, 2022). Female labour force participation remains at 56.42% compared to 84.66% for men, reflecting persistent structural gaps. In disasters, women and children face higher mortality and displacement risks, and bear the caregiving burden during recovery (BPS, 2024b). Indonesia's Gender Development Index (GDI) of around 0.945 and its Gender Inequality Index (GII) of around 0.423, remain higher than many middle-income peers (UNDP, 2025). Gender-responsive adaptation is therefore essential, aligning with SDG 5 (Gender Equality) and UNFCCC principles.

'RAN-GPI 2024–2030 provides the national framework for integrating gender and vulnerable-group considerations into the NAP, ensuring alignment with the UNFCCC Gender Action Plan and Enhanced Transparency Framework'

Indonesia's ecological assets underpin both livelihoods and national resilience, yet they are under increasing stress from climate change and human pressures. The country contains 120.4 million hectares of forested land (SOIFO, 2024), 13.4 million hectares of peatlands, and 3.36 million hectares of mangroves (Bappenas, 2025a). In addition, it harbours 2.53 million hectares of coral reefs (around 10.54% of the global total) and extensive seagrass meadows, vital for fisheries and carbon storage. These ecosystems regulate water flows, protect against disasters, sequester carbon, and sustain biodiversity, making them indispensable to Indonesia's adaptation capacity.

- Forests remain central to biodiversity and carbon regulation but are increasingly affected by deforestation, fires, and droughts.
- Peatlands are highly sensitive to ENSO-driven droughts, which trigger large-scale fires releasing haze and GHGs.
- Mangroves are threatened by sea level rise and coastal development, weakening natural flood defences and fisheries support.
- Coral reefs and seagrass face bleaching, ocean acidification, and sedimentation, undermining fisheries and coastal livelihoods.
- Lakes and watersheds are impacted by changing rainfall patterns, water scarcity, and pollution, threatening irrigation and hydropower reliability.
- Grasslands and savannas, particularly in NTT and Papua, are prone to drought and fire, affecting pastoral livelihoods.
- Small islands ecosystems face freshwater scarcity, saltwater intrusion, and high exposure to sea level rise and storms.

The IBSAP (2025–2045) highlights that biodiversity and ecosystem degradation undermine Indonesia's ability to achieve development targets and global commitments under the Kunming–Montreal Global Biodiversity Framework (Bappenas, 2025a). To address this, the plan introduces a Biodiversity Management Index (Indeks Pengelolaan Kehati) to track progress through three dimensions: (i) ecological, covering ecosystem distribution, health status, key species populations and habitat connectivity; (ii) socio-economic, reflecting community participation and economic benefits; and (iii) governance, encompassing policy, institutional capacity, budgeting, monitoring systems, databases and law enforcement. This composite index serves as an operational tool that can be integrated into adaptation monitoring frameworks.

Bamboo stakes as protection for mangroves in the Angke Kapuk Protection Forest - © Piarea

Box 2.3 – Biodiversity and Development Nexus within Indonesia's NAP

Biodiversity and climate change form an indivisible nexus that underpins Indonesia's adaptation priorities. Climate change accelerates biodiversity loss through sea level rise, coral bleaching, peatland fires, and forest degradation, while biodiversity decline in turn erodes ecosystem services that sustain adaptation - such as carbon sequestration, flood regulation, food and nutrition security, and public health. This feedback loop is a critical driver of socio-economic vulnerability and fiscal strain, with climate and disaster-related losses in priority sectors already exceeding IDR 100 trillion per year, reaching IDR 102.36 trillion in 2020 and IDR 115.53 trillion in 2024 (Government of Indonesia, 2022b), which constrains development space.

Within the *National Adaptation Plan (NAP)* framework, biodiversity is not treated solely as an environmental concern but as a cross-cutting asset for resilience. The IBSAP 2025–2045 projects that without effective intervention, natural habitat cover could fall from 80.3% in 2000 to 49.7% by 2045 (Bappenas, 2025a). Such degradation would intensify *loss and damage* in agriculture, fisheries, coastal infrastructure, and health, undermining the achievement of SDGs, particularly SDG 1 (No Poverty), SDG 2 (Zero Hunger), SDG 3 (Good Health and Wellbeing), SDG 13 (Climate Action), SDG 14 (Life Below Water), and SDG 15 (Life on Land). Conversely, restoration of mangroves, peatlands, and coral reefs provides measurable adaptation benefits by reducing storm surges, limiting greenhouse gas emissions, sustaining food systems, and strengthening fiscal resilience.

Globally, Indonesia's commitment to the Kunming–Montreal Global Biodiversity Framework (KMF) reinforces this nexus by pledging to protect 30% of terrestrial and marine areas by 2030 (UNCBD, 2022), mainstream biodiversity into productive sectors, and mobilide biodiversity finance. These global targets dovetail with the NAP's objectives on economic, social, and ecosystem resilience, while providing a bridge to SDG implementation and long-term prosperity.

Under the Enhanced Transparency Framework (ETF) of UNFCCC Article 13, biodiversity measures contribute directly to adaptation reporting, enabling Indonesia to show how actions such as mangrove rehabilitation or ecosystem-based adaptation (EbA) generate co-benefits for climate resilience, disaster risk reduction, poverty reduction, and SDG progress. This ensures that biodiversity action is not only a conservation priority but also a measurable contribution to national and international development commitments.

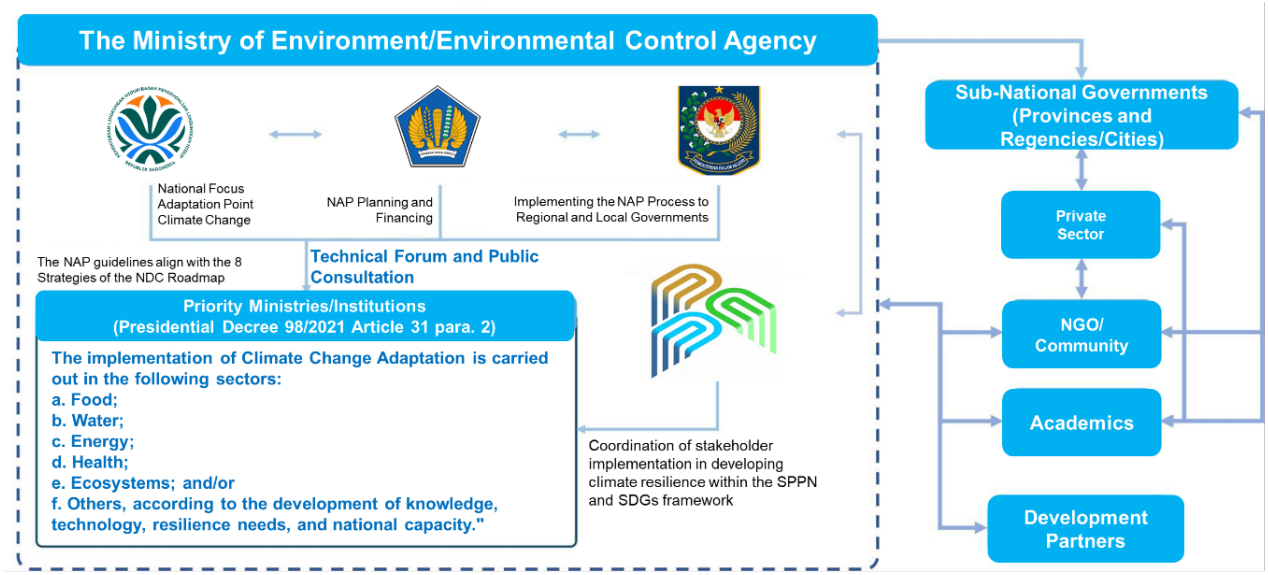
Finally, inclusivity is central. Both the IBSAP and NAP emphasise the role of Indigenous Peoples, women, youth, and vulnerable groups, consistent with the KMF and UNFCCC's gender-responsive adaptation principles. Embedding biodiversity into the NAP therefore secures ecological and economic resilience while also delivering on the leave no one behind agenda of the SDGs.

2.4 Institutional and Governance Arrangements

Since ratifying the Paris Agreement (through Law No. 16/2016), Indonesia has built a multi-level adaptation governance framework. Presidential Decree 148 and 149 (2024) separated the former KLHK into the Ministry of Environment (KLH) and the Ministry of Forestry (Kemenhut). KLH acts as UNFCCC national focal point, coordinating adaptation policy and reporting (Government of Indonesia, 2022b, 2024a). Kemen PPN/Bappenas mainstreams resilience into the RPJMN and RPJPN; the Ministry of Finance (Kemenkeu) implements Climate Budget Tagging; the Ministry of Public Works (Kemen PU) and Ministry of Housing and Settlements (Kemen PR) handle infrastructure and settlement resilience, respectively; and sectoral ministries (Kementan, Kemenkes, ESDM, BNPB) lead priority actions.

At the national level, Kemen PPN/Bappenas provides overarching coordination by integrating adaptation into the RPJMN 2025–2029 and the RPJPN 2025–2045, ensuring coherence between climate resilience and long-term development pathways (Bappenas, 2025c). KLH leads the formulation of adaptation policy, manages international submissions such as the Adaptation Communication (Government of Indonesia, 2022b) and the Biennial Transparency Report (Government of Indonesia, 2024a), and oversees registry and monitoring systems (SRN), Kemenhut strengthens ecosystem-based adaptation through forest conservation, peatland management and mangrove restoration (Murdiyarso et al., 2015). The Ministry of Finance provides fiscal governance by applying Climate Budget Tagging (CBT) and integrating adaptation into planning and budgeting systems through AKSARA (Government of Indonesia, 2022b; UNDP, 2021). In parallel, the Ministry of Public Works and Public Housing (PUPR) split into Kemen PU, which oversees infrastructure and water management, and Kemen PR, responsible for climate-resilient housing and settlement development (Bappenas, 2025b).

NAP Public Consultation, © CLARITY, GIZ, 2025



Institutional Functions and Roles In the National Adaptation Plan

Steering Committee : a
Provide strategic NAP oversight and ensuring alignment of cross-sectoral adaptation initiatives with NAP

Expert Consultative Group: b c d
Role: Aligning NAP with UNFCCC, allocates funding, oversees subnational adaptation, supports regional implementation.
Responsibilities: Ensure the embodiment of NAP in Subnational level and provide their financial and non-financial needed

Involved Ministries/Institutions: e f g h i j k
Role : Integrating NAP into cross-cutting issues
Responsibilities: Tailored adaptation strategies in cross-cutting priority sectors

Local Government l
Role : Implementing NAP strategies at local level
Responsibilities: Adapt policies to local needs, engage communities, and report NAP progress to the steering committee.

Civil Society Organization : n
Role : Facilitate community adaptation, raise awareness, advocate for inclusive, local strategies.
Responsibilities : Guide community adaptation planning and education, advocate for vulnerable populations, integrate local knowledge, implement evidence-based actions, monitor resilience impact effectively.

Other Non-Party Stakeholders m o p
Role : Providing essential resources, expertise, and innovation to strengthen NAP.
Respobsibilities: private sector and development partner provide NAP financial support , while academia develop holistic climate risk research and evidence-based adaptation

Advancing NAP Implementation

Creating Knowledge Management Platform (KMP)

Phase 1: a b c d p
Phase 2: b e f g h i j k l m
Phase 3: b c d e l n o

Output : secured NAP digital framework, multi-sectoral NAP repository, NAP monitoring dashboard, annual evaluation report
Measures : Platform completion, stakeholder user engagement, data update frequency, NAP impact indicators, evaluation-based adjustments

National Adaptation Plan

Creating Resourcces Mobilization Strategy (RMS)

Phase 1: a b c m p
Phase 2: b c e l m
Phase 3: b c e l n o

Output : Resources mobilization strategy document, mobilized funding for adaptation projects, NAP funds tracking, monitoring, and reporting system, annual evaluation and strategy adjustment
Measures :
Resource strategy document completed, funds mobilized, partnerships/projects funded, regular reports, annual evaluations/adjustments.

Legend :

Steering Committee
a. MoE (NFP)
c. MoF
d. MHA

Non-Party Stakeholders
l. Local Government
m. Private Sector
n. Civil Society Organization
o. University
p. Development Partner

Involved Ministries and Non. Ministries Government Institutions
e. MNDP
f. MoA
g. MoPW & MoPH
h. MoEMR
i. MoH
j. MoFo
k. NADC

Advancing NAP Implementation
Creating Knowledge Management Platform
Phase 1 : Development of Knowledge Management Platform
Phase 2 : Implementation and Data Integration
Phase 3 : Tracking, Monitoring, and Evaluation of Knowledge Sharing
Creating Resources Mobilization Strategy
Enabling Environment : a b c d
Funding

Figure 2.4 National institutional arrangement for adaptation and DRM showing roles of KLH, Bappenas, BNPB, and sectoral ministries.

Sectoral ministries play central roles in operationalising adaptation in the priority areas identified in the Adaptation Communication (Government of Indonesia, 2022b):

- The Ministry of Agriculture (Kementan): food security and climate-resilient farming (Government of Indonesia, 2022b).
- Ministry of Public Works (KemenPU): water infrastructure, drainage, flood control (Government of Indonesia, 2024b).
- Ministry of Housing and Settlements: climate-resilient housing and relocation of vulnerable communities (Bappenas, 2025b).
- Ministry of Energy and Mineral Resources (ESDM): diversification and adaptation of energy systems (Government of Indonesia, 2022b).
- Ministry of Health (Kemenkes): climate-sensitive health services, surveillance and resilience of health facilities (WHO, 2015).
- National Disaster Management Agency (BNPB): early warning, contingency planning and disaster recovery (UNDRR, 2022).
- Ministry of Environment (KLH/BPLH), Ministry of Marine and Fisheries (MoMF), and Ministry of Forestry (Kemenhut): ecosystems, biodiversity, carbon-rich landscapes and ecosystem services (Government of Indonesia, 2024b; Murdiyarso et al., 2015).

These mandates collectively ensure that adaptation is embedded within sectoral and cross-sectoral governance, reflecting the multi-dimensional nature of climate risks (Bappenas, 2025c).

Decentralisation requires provinces and regencies/municipalities to prepare RAD-API/RAAPID regional climate change adaptation plan documents for integration into RPJMD and environmental protection and management plans (RPPLH) (Perpres 110/2025; Permen LHK 12/2024). Capacity and finance gaps persist, highlighting the need for stronger local technical systems. Multi-actor engagement is central: academia, NGOs, private sector, and communities contribute through consultations and the ProKlim programme. International partners (GCF, GEF, ADB, UN agencies, bilaterals) align support with national systems.

Sanggau Woman Planting Activities, ©SAFE, GIZ, 2025

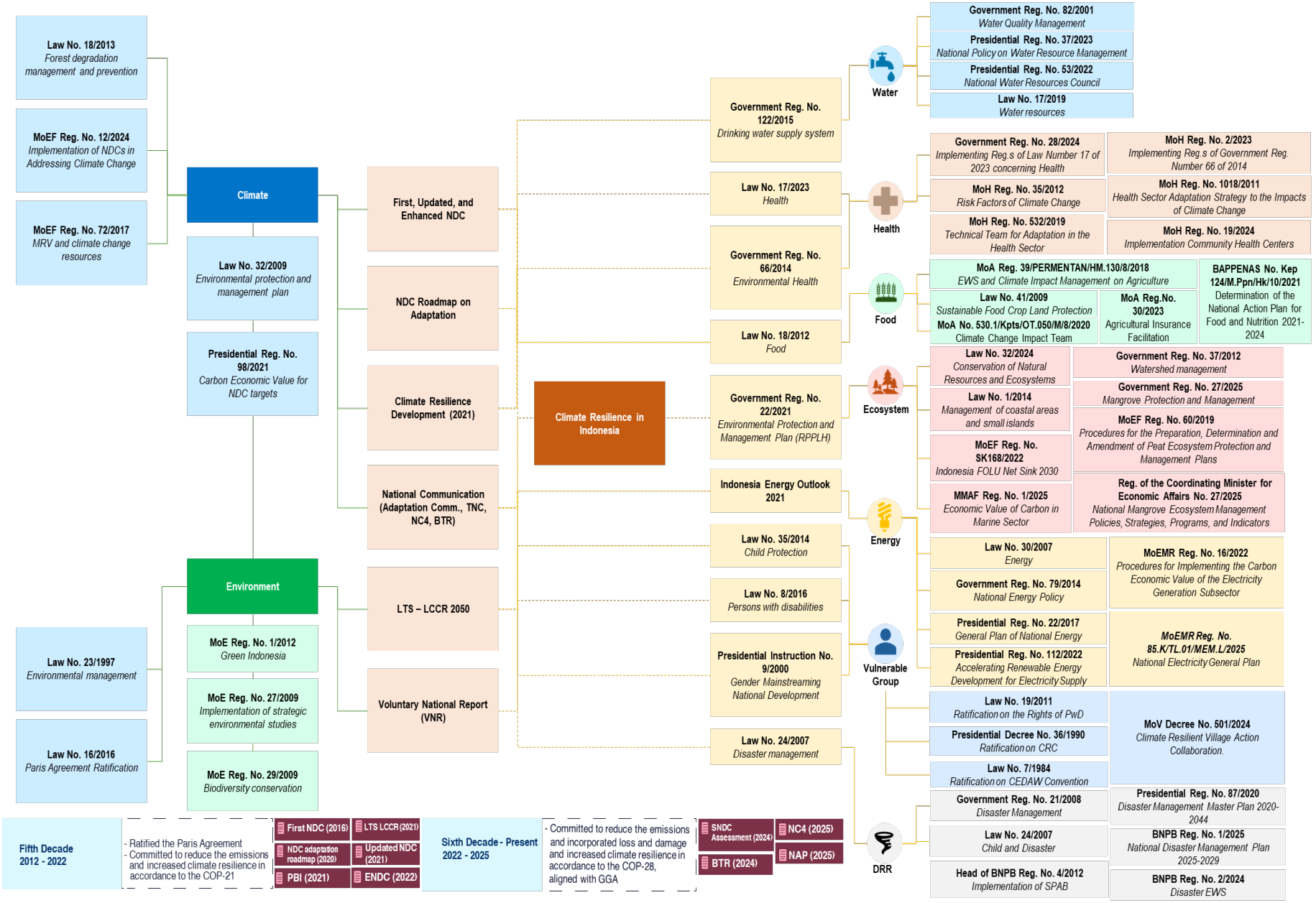


Figure 2.5 Major environmental and climate regulations supporting adaptation and transparency (2012–2032)

Gamalama Volcano, North Maluku © Widhi, MoE/EPA, 2025

3

NAP PROCESSES

3.1 Context and Rationale

Indonesia's National Adaptation Plan (NAP) was developed between July and October 2025 through a nationally led, evidence-based process that integrates global scientific guidance with Indonesia's established data and institutional systems. Given the limited preparation window, the NAP adopted a modality-led dual-track methodology (combining scientific rigour and practical governance) to ensure that outputs are measurable, reportable and verifiable while remaining consistent with national capacities and policy frameworks.

Rather than reconstructing a full IPCC-style analytical cascade, the NAP synthesised validated information from key national documents: the NDC Adaptation Roadmap (2020), Climate-Resilient Development (PBI) policy (2021), Long-Term Strategy for Low Carbon and Climate Resilience (LTS-LCCR, 2021), Adaptation Communication (2022), Climate Landscape Analysis for Children in Indonesia (2023), and the Biennial Transparency Report (2024). These materials already contained quantitative analyses of climate hazards, impacts and adaptation progress. The NAP therefore functions as an integrative framework to consolidating those data into one coherent methodological system. The national data modalities supporting the NAP include:

- BMKG for surface climate observations over terrestrial areas. (https://dataonline.bmkg.go.id);
- BNPB InaRisk for hazard mapping, exposure, and disaster-loss records (https://inarisk.bnpb.go.id);
- BPS for population, economic, and asset statistics;
- SIDIK (KLH) for socio-economic vulnerability indices (https://sidik.menlhk.go.id);
- IBSAP 2025–2045 for ecosystem sensitivity and biodiversity data;
- SRN-PPI Registry for adaptation and mitigation project data (https://srn.menlhk.go.id);
- AKSARA and Climate Budget Tagging (CBT) under the Ministry of Finance for adaptation-related expenditure tracking.

Integrating these systems enables traceable, cost-efficient analysis compatible with the Enhanced Transparency Framework (ETF) and the Global Goal on Adaptation (GGA). The approach rests on three principles:

1. Maintaining scientific credibility consistent with IPCC AR6 and UNFCCC NAP Guidelines (2012; 2025 update) (UNFCCC, 2025b);
2. Ensuring national ownership through existing institutions and databases; and
3. Delivering results within a constrained timeline without compromising data quality or verification.

Box 3.1 – Alignment of NAP sections with UNFCCC NAP elements (A–D)

NAP Element	Purpose	Reflected in NAP Sections	How It Is Addressed
A – Laying the groundwork	Establish enabling conditions, institutional arrangements and data systems.	Chapters 1–3	Chapter 1 introduces the NAP's rationale and legal mandates; Chapter 2 outlines national circumstances and data frameworks; Chapter 3 details the integration of BMKG, BNPB, BPS, SIDIK, IBSAP, and SRN-PPI and the multi-stakeholder validation process that closes information gaps.
B – Preparatory elements	Conduct climate analyses, identify risks and formulate options.	Chapters 3–6	Chapter 3 explains the methods for atmospheric and marine baselines (1991–2020) and HIVER-based risk coding; Chapter 4 presents observed and projected climates; Chapter 5 quantifies sectoral vulnerability; Chapter 6 translates these risks into adaptation portfolios aligned with resilience targets.
C – Implementation strategies	Integrate adaptation into policy and resource frameworks.	Chapters 6–7	Chapter 6 develops strategic actions and national/sectoral plans; Chapter 7 links them to institutional roles, budget mechanisms, and financing pathways in accordance with Perpres 110/2025 and Permen LHK 12/2024.
D – Reporting, monitoring, and learning	Track progress, ensure accountability, and support iterative improvement.	Chapters 7–8	Chapter 7 defines operational indicators; Chapter 8 establishes the MEL Adaptation system aligned with ETF and GGA, linking planning, budgeting, and reporting through indicators and Risk Codes.

3.2 Guiding Framework and Principles

3.2.1 Principle Concept

The NAP's conceptual framework situates adaptation as a cyclical, multi-sectoral process connecting scientific evidence, policy design, implementation and monitoring. At the global level, it aligns with the UNFCCC NAP Technical Guidelines (2012; 2025), the GGA, the ETF, and mechanisms under the Loss and Damage (L&D) framework including the Warsaw Mechanism and Santiago Network (UNFCCC, 2025a). At the national level, it operationalises UU 16/2016 (ratification of the Paris Agreement) (UNFCCC, 2015), Presidential Decree 110/2025 (Carbon Governance), and MoEF Regulation 12/2024 (Climate Change Adaptation). These instruments embed adaptation within the RPJMN 2025–2029 and RPJPN 2025-2045 development plans. Guiding principles include:

- Inclusivity and participation across ministries, regions, communities and partners;
- Gender responsiveness and social equity, recognising differentiated impacts (UNICEF, 2023);
- Ecosystem- and community-based approaches (EbA) as the core implementation model;
- Evidence-based and SMART planning (Specific, Measurable, Achievable, Relevant, Time-bound); and
- Adaptive management, allowing iterative revision (IPCC, 2022a).

3.2.2 Structural Design

The innovation in Indonesia's NAP lies in presenting both the ideal scientific flow and the practical application using national modalities in a single coherent framework. This is summarised in the table below. Indonesia's NAP employs a Dual-Track Methodology that integrates the HIVER framework (Hazard, Impact, Vulnerability, Exposure, Risk, and Adaptation Option) with national data systems.

- Hazards are identified using BMKG atmospheric and marine records (1991–2020);
- Impacts draw on sectoral data from Kementan, Kemenkes, KemenPU and ESDM;
- Vulnerability and Exposure use SIDIK and BPS indices verified with BNPB loss data;
- Risk codes link these datasets for traceability across Chapter 4–8.

Table 3.1 Dual-track methodology for historical and projected climate analysis

Ideal IPCC-Aligned Flow	Indonesia's NAP Practical Application
Homogenised long-term station datasets; extreme indices; hazard overlays with loss data	BMKG Climate Change Portal + InaRisk disaster records integrated with loss estimates from NDC Roadmap and LTS-LCCR
CMIP6 multi-model ensembles downscaled with CORDEX-SEA; bias correction and probabilistic treatment of SSPs	BMKG national projections (CMIP6, CORDEX-SEA) as presented in ENDC, AdCom, and BTR for priority sectors
Integration of socio-economic layers (exposure, sensitivity, adaptive capacity) using global and national indices	SIDIK vulnerability index (based on BPS datasets) to link climate with socio-economic vulnerabilities
Cascading/compound impact modeling to capture cross-sectoral risks	Approximation of cascading risks using national reports (PBI, CLAC, AdCom) and community inputs (ProKlim communities, CSOs)

Through this dual-track method, Indonesia's NAP produces outputs that are both scientifically robust and policy-ready:

- A national synthesis of historical climate baselines, highlighting observed variability and extremes across temperature, rainfall, humidity, winds, and cyclones, linked with hazard and socio-economic impacts;
- A set of future climate envelopes for Indonesia, grounded in BMKG projections and aligned with IPCC AR6 scenarios;
- An uncertainty range across shared socio-economic pathways (SSPs) 2–4.5 and 5–8.5, presented in relevant formats.

Clear integration into Chapter 4 (Historical and Future Climates) and Chapter 5 (Impacts, Vulnerabilities, Risks), in turn support Chapter 6 (Adaptation Option Design), Chapter 7 (Operationalisation), and Chapter 8 (Monitoring).

Southwest Sumba, ©Heny PA,MoE/EPA, 2025

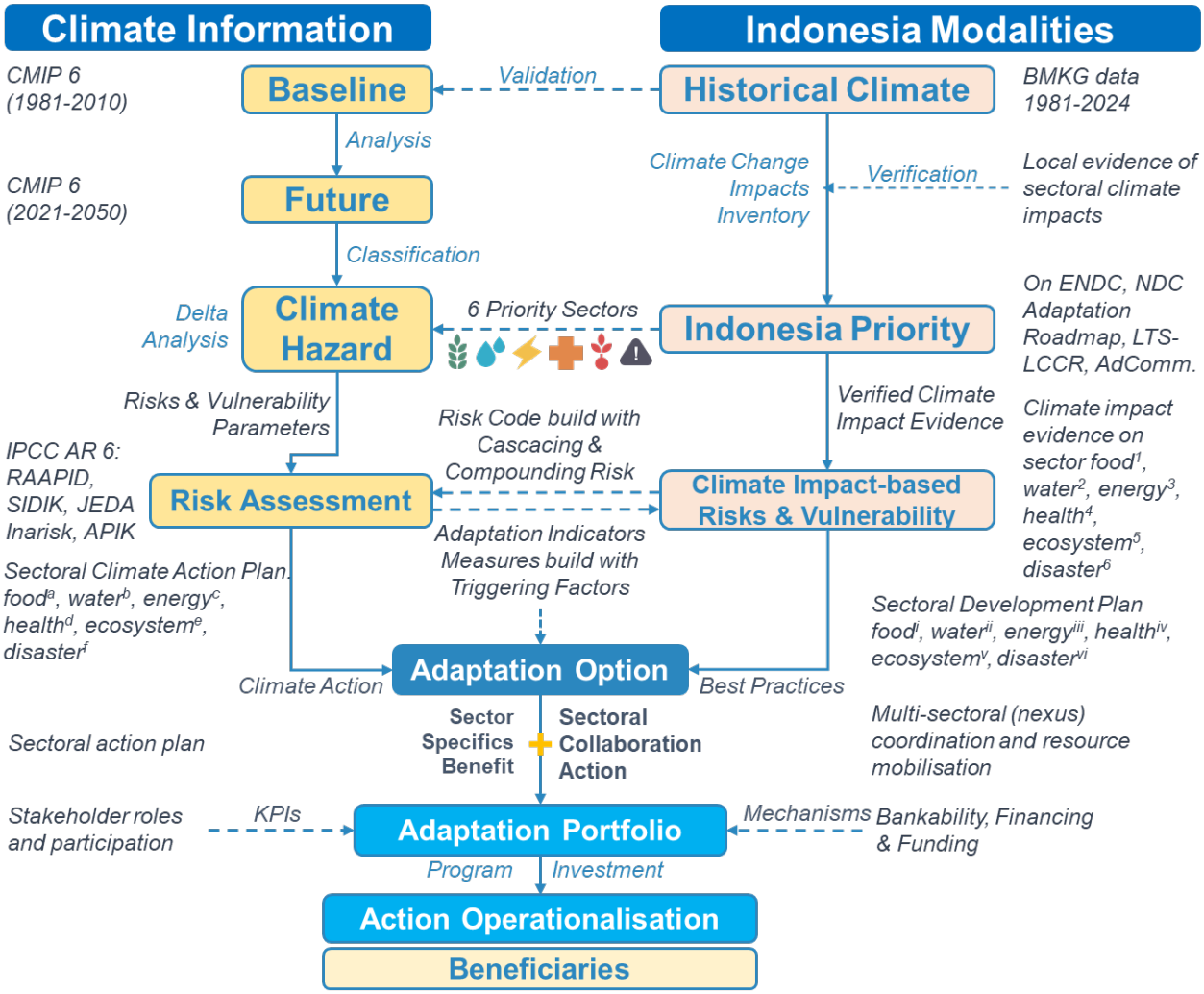


Figure 3.2 Science–Policy Interface for Indonesia's NAP. The figure illustrates the dual-track approach that combines the IPCC's ideal science-based flow with Indonesia's national modalities. Historical baselines and climate projections from the IPCC AR6 framework are integrated with BMKG portals, InaRisk, and SIDIK, supported by the NDC Roadmap, ENDC, and AdCom. This blended approach ensures scientific credibility while maximising national relevance and investment, producing risk assessments and adaptation options that inform NAP Chapters 4–8. Indonesia's innovation lies in operationalising global guidance through its existing national systems, ensuring feasibility, transparency, and alignment with the Enhanced Transparency Framework (ETF).

Coastal Traditional House, Southeast Sulawesi, © UNDP Indonesia, 2025

3.3 Methods and Modalities

3.3.1 Evidence and Baselines (1991–2020 Atmospheric and Marine Periods)

The evidence base comprises both atmospheric and marine datasets for 1991–2020, forming the quantitative foundation for Chapter 4.

Historical Climate Analysis

Data from BMKG Climate Data Online were homogenised and converted into 0.1° grids covering temperature, rainfall, humidity, and wind. Extreme-climate indices (Txx, Tnn, CDD, Rx5day) follow ETCCDI/IPCC AR6 standards (BMKG, 2024; IPCC, 2022). Results provide regional statistics for use in impact assessments (Chapter 4 and 5). Marine parameters — Sea Surface Temperature (SST), Sea Level Rise (SLR), Salinity Currents, and Waves— were compiled from BMKG marine observations, BIG hydro-oceanographic records, BRIN satellite data, and reanalysis products (NOAA OISST v2, CMEMS). Calibration against tide gauges and satellite altimetry produced indices for SST trend (°C dec^{-1}) and mean SLR (mm yr^{-1}). These feed Section 4.2 on sea-based climate patterns.

Projected Climate Analysis

Downscaled BMKG CMIP6/CORDEX-SEA simulations (SSP 2-4.5 and SSP 5-8.5) extend the baselines to 2021–2050 and beyond. Observed and modelled datasets are paired for comparability. All indices and metadata are documented in Annex 3B for reproducibility.

3.3.2 Hazard-Impact–Vulnerability–Exposure–Risk Assessment (HIVER Core)

Following HIVER, risks are quantified by linking hazard, impact, vulnerability, and exposure. Hazards include temperature rise, extreme rainfall, drought and sea level rise; impacts are measured through yield loss, water deficit, health risk, and ecosystem stress. Vulnerability indices derive from SIDIK and IBSAP, while exposure maps use BPS and BNPB data. Each combination receives a Risk Code, e.g., H01-A-Java (flood–agriculture–Java). Codes are referenced throughout Chapters 5–8 and listed in Annex 3C to ensure traceability.

Table 3.2 Climate pressures & impact inventory. Each hazard–impact pair is coded for traceability, ensuring a transparent link from climate parameters to sectoral risks and geographic hotspots. The coding provides the audit trail required under Perpres 110/2025, Permen LHK 12/2024, and UNFCCC ETF/BTR reporting.

Code	Climate Parameter (Trigger)	Specific Climate Data	Climate Extremes / Disasters	Data Type & Unit	Potential Impacts / Risks	Geographic Hotspot
F-01	Seasonal rainfall	Monthly total rainfall (mm)	Floods	Rainfall anomalies, mm	Crop loss, food price volatility	Central Java, South Kalimantan
D-02	Dry season rainfall deficit	% deviation from baseline	Droughts	SPI, % anomaly	Water scarcity, crop failure	East Nusa Tenggara, West Timor
H-03	Maximum temperature	°C anomaly from baseline	Heat stress	Daily Tmax	Heat stress, vector-borne disease expansion	Jakarta, North Sumatra

3.3.3 Design and Prioritisation of Adaptation Options

Adaptation options derived from HIVER analysis are organised into resilience-oriented portfolios that directly support national targets. Prioritisation is based on alignment with three resilience pillars rather than algorithmic ranking:

1. Economic resilience: maintaining productivity and infrastructure under climate stress (e.g. climate smart agriculture, efficient irrigation, resilient transport, lower healthcare costs);
2. Social and livelihood resilience: protecting health and income (e.g. community early-warning systems, health risk management, livelihood diversification);
3. Ecosystem and landscape resilience: protecting and restoring ecosystems (e.g. mangrove rehabilitation, watershed management, forest fire prevention).

Portfolios are validated through three steps: (1) alignment with the NDC Adaptation Roadmap (2020), LTS-LCCR (2021), and AdCom (2022); (2) stakeholder review (3.3.4); and (3) feasibility check for policy and budget coherence with the RPJMN 2025–2029.

3.3.4 Stakeholder Engagement and Validation

Multi-stakeholder engagement was central to data validation and ownership. Participants included KLH/BPLH, Kemenhut, Kemen PPN/Bappenas, BMKG, BNPB, Kementan, Kemenkes, ESDM, provincial and regency/municipal governments, academia (BRIN, universities), civil society (ProKlim communities), and development partners (GIZ, UNDP, UNICEF, Mercy Corps Indonesia, WHO, WWF, ICLEI, Save The Children, UNFPA and UN Women). Consultations refined risk maps and portfolios through iterative feedback. To capture the breadth of perspectives and inputs, engagement was sequenced into three phases: inception

and stocktaking; technical consultations; and consolidation/validation, spanning from the Kick-off Meeting on 9 May 2025, the first focus group discussion FGD 1 (1 July 2025) scoped sectoral issues through breakout groups in food, water, health, energy, ecosystems, and disaster risk; FGD 2 (25 August 2025) compiled climate risk analyses and adaptation strategy blocks; FGD 3 (16–17 September 2025) convened regional consultations in Semarang, Kendari, and Pekanbaru to identify regional/sub-national priority; while FGD 4 and 5 (October 2025) finalised adaptation priorities through a national public consultation. This was followed by the National Technical Consultation on 16 October 2025, public input sessions during 16–22 October, and the Final Stakeholder Consultation on 31 October 2025, which was attended by over 123 institutional representatives both offline and online. Additional inputs were collected through the NAP online platform nap.piarea.co.id until 2 November 2025, generating more than 641 written comments. Contributions ranged from data and information supply, clarification and validation, to recommendations on institutional coherence and financing mechanisms—demonstrating Indonesia's strong commitment to inclusive, science-based adaptation planning.

In addition to these clustered FGDs, some thematic input workshops were conducted. A Capacity Building Workshop on Ecosystem-based Adaptation (EbA) to Inform Indonesia's NAP Development (25–26 September 2025 explored ways to integrate EbA, using healthy ecosystems like forests, wetlands, and mangroves to reduce climate risks, into Indonesia's NAP. Drawing on experiences from Fiji, Timor-Leste, and Wakatobi, it fostered dialogue on planning, financing, and monitoring, and produced key recommendations to strengthen ecosystem resilience in national adaptation efforts.

Key Informant Interviews (KIIs) were conducted in parallel with targeted experts-on adaptation finance, monitoring systems, indigenous knowledge, and private sector engagement-providing specialised depth to complement the broader discussion. The entire process was reinforced by horizontal and vertical coordination mechanisms. At the horizontal level, Technical Working Groups (TWGs) and Ministry/Agency FGDs validated climate data, sectoral risk assessments and institutional roles. At the vertical level, regional FGDs engaged provincial and regency/municipal actors to align national assessments with local realities, producing operational adaptation matrices and validating priorities with local governments and the ProKlim communities. Communities, particularly through ProKlim, contributed lived experiences and local adaptation practices, ensuring that grassroots knowledge was embedded into the NAP.

These forms of engagement were not isolated but interactive. Data generated by ministries fed into regional consultations; local validation informed sectoral analyses; and community proposals were aggregated into national portfolios. Thematic FGDs, TWGs and KIIs complemented one another, ensuring that evidence, priorities and solutions were triangulated across scales. The following matrix (Table 3.3) presents the engagement formats, participants, timing, agendas, and outputs, showing how each activity directly contributed to the drafting of Chapters 4–8 of the NAP.

Table 3.3 Stakeholder Engagement and Contributions to NAP Drafting (with Thematic Clusters).

Engagement Format	Type	Stakeholders Involved	Timing (2025)	Agenda / Thematic Coverage	Main Outputs	Linked NAP Sections
Kick-off Meeting and Policy Alignment Workshop	National workshop (offline)	KLH/BPLH, line ministries, partners	9 May	Launch of NAP process, mandate alignment, addressing initial gaps	Slide deck, synthesis of policies and regulations, identification of technical and financial support	Introduction (Ch. 1)
FGD 1 – Scoping and Stocktaking	Sectoral FGD with breakout rooms	Line ministries (food, water, health, energy, ecosystems, DRR), environment offices, ProKlim	1 July	Identification of sectoral issues, mapping modalities, gaps and needs	Geospatial database, baseline vulnerability/impact assessment, inventory of climate impacts, synthesis of tools, policies, best practices	Preparation Elements (Ch. 2 -3)
FGD 2 – Climate Risk and Sectoral Priorities	Technical consultation	KLH/BPLH, line ministries, technical agencies, researchers	25 August	Compilation of climate projections and sectoral risk assessments; identification of adaptation "Action Blocks"	Tabulation of climate projections (rainfall, temperature, extremes), list of adaptation actions, clustered strategies aligned with RPJMN & RPJP 2045	Preparation Elements (Ch. 4-5)
FGD 3 – Regional Consultations (Java, Sulawesi, Sumatra)	Regional FGDs	Provincial and regency/ municipal governments, environment offices, ProKlim communities, CSOs	16–17 September	Regional adaptation priorities, local challenges and opportunities	Regional priority adaptation lists, operational matrices, local governance readiness (databases, communication portals)	Regional Priorities (Ch. 3-6)
Capacity Building Workshop on EbA to Inform Indonesia's NAP Development Process	Workshop	Line ministries, institutional actors, KLH/ BPLH	25-26 September	- Enhance knowledge of EbA and ecosystem resilience as NAP key components. - Examine best practices and approaches from selected countries' submitted NAPs. - Facilitate dialogue between policymakers, practitioners, and experts on how EbA can be mainstreamed into NAP processes. - Identify entry points and for Indonesia's NAP based on global experiences - Recommendations for Indonesia's NAP based on global experiences.	Shared knowledge and best practices selected submitted of NAP focussing on EbA, M&E and Loss & Damage. Recommendation on integrating EbA into NAP process	Regional Priorities and Impact (Ch. 3-6)

Engagement Format	Type	Stakeholders Involved	Timing (2025)	Agenda / Thematic Coverage	Main Outputs	Linked NAP Sections
Children and Youth Consultation	FGD	Children and Youth Organization	6 October 2025	Consolidation of U-Report poll on the 2025 for NAP issue	Inputs from youth and children for climate action	Regional Priorities and Impact (Ch. 3-6)
FGD 4 – Institutional Governance and Policy Coherence	Sectoral FGD Validation	Line ministries, institutional actors, KLH/ BPLH	15 – 16 October	- Prioritisation of adaptation actions; institutional mapping and coordination - Adaptation finance modalities (CBT, PPP, green bonds, private investment)	- Institutional coordination maps, policy readiness assessment, matrix of roles, functions - Policy synthesis on adaptation finance support, preliminary financing strategies - Stakeholder validation report, compilation of feedback for NAP finalization	Implementation Strategy (Ch. 7) Reporting, Monitoring and Review (Ch. 8)
FGD 5 – Public Consultation on Draft NAP	National Consultation	Broad stakeholders, CSOs, academia, community reps	31 October	Full and NAP draft	Stakeholder Consultation	All Chapter

This design demonstrates that stakeholder engagement was sequenced, clustered, and purposive. By combining FGDs into clusters, aligning them with sectoral mandates and enablers, and complementing them with regional consultations and KIIs, the process ensured that the drafting of Chapters 4–8 of the NAP was built on broad, validated and inclusive evidence. At the same time, the documentation of every consultation provides a transparent record, ensuring full compliance with the ETF and other UNFCCC requirements. The stakeholder engagement framework outlined in Section 3.3 not only ensures inclusivity in the design process but also lays the groundwork for operational delivery and monitoring of adaptation actions. Engagement is structured to:

Operationalisation (Chapter 7): By mapping roles across ministries, subnational governments, civil society, communities and the private sector, the engagement approach clarifies who will implement which parts of the portfolio, under what mandates and with what forms of collaboration. This reflects the requirements of Presidential Decree 110/2025 (Article 47-49) and MoEF Regulation 12/2024 (Article 70–77), which mandate coordination across levels of government and inclusion of non-state actors in adaptation delivery.

Monitoring and Evaluation (Chapter 8): Engagement also defines the channels for data

collection, reporting, and validation. National platforms such as SIDIK, InaRisk and AKSARA will be enriched by inputs from local governments, academia, NGOs and communities. This supports compliance with ETF transparency requirements and MoEF Regultaion 12/2024 (Article 93–99), ensuring that adaptation results are measured, validated and reported consistently.

Thus, stakeholder engagement is not only about consultation but about institutionalising participation into both implementation and monitoring systems. In this way, Section 3.3 directly informs the governance arrangements required in Chapter 7 and the MEL framework to be detailed in Chapter 8. Collectively, the methodologies presented in Chapter 3 provide the technical backbone of the NAP. They ensure that climate risks are systematically identified, adaptation options are designed and prioritised with measurable outcomes, and stakeholder roles are mapped for delivery and reporting. As such, Chapter 3 serves as the foundation not only for Chapters 4–6 (risk assessments and adaptation options), but also for Chapter 7 (operationalisation) and Chapter 8 (monitoring and evaluation), thereby ensuring the NAP is risk-informed, operational, and accountable. This process fulfils Element A (Groundwork and Gaps) of the NAP Guidelines and ensures inclusive and equitable planning.

3.3.5 Adaptive Management and MEL Adaptation

Adaptive management links planning to learning through SMART indicators monitored in SRN-PPI and AKSARA. Quantitative metrics (area restored, households protected, losses avoided) and qualitative metrics (policy integration, institutional capacity) support continuous learning and ETF reporting. The methodological sequence outlined in Chapter 3 from establishing atmospheric and marine baselines (Section 3.3.1) through HIVER-based risk assessment (Section 3.3.2), resilience-portfolio design (Section 3.3.3), stakeholder validation (Section 3.3.4), and adaptive management (Section 3.3.5) forms the analytical engine of Indonesia's NAP. These procedures generate the data, codes, and indicator logic used in. Chapters 4–8: Chapter 4 provides climate evidence; Chapter 5 analyses impacts and vulnerabilities; Chapter 6 formulates strategies; Chapter 7 operationalises financing and implementation; and Chapter 8 establishes MEL Adaptation for ETF reporting. Chapter 3 thus serves as the methodological foundation for the entire NAP results chain.

Women in South East Sulawesi © UNDP, Indonesia, 2025

4

CLIMATE TRENDS AND FUTURE PROJECTIONS

4.1 Historical Climate Conditions and Trends

Long-term observations confirm that Indonesia's land and sea are warming simultaneously. National mean surface air temperature increased by approximately +0.81°C relative to the 1991–2020 baseline (BMKG, 2025; Government of Indonesia, 2022b; KLHK, 2020; World Bank, 2025), while sea-surface temperature (SST) rose by +0.20°C per decade. Minimum (night-time) temperatures increased faster than daily maxima, intensifying heat retention and reducing nocturnal cooling in urban zones. Warming is most pronounced over Java, Sumatra, southern Kalimantan, Sulawesi, and Papua, consistent with IPCC AR6 regional assessments (BMKG, 2025; IPCC, 2021).

Rainfall variability exhibits a north–west wetting and south–east drying gradient. Northern Sumatra, Kalimantan, and Sulawesi experienced mean increases of +5% to +10% per decade, while Java, Bali, and Nusa Tenggara recorded −5% to −15"% per decade. Extreme-rainfall indices (Rx1day, R95p) rose across the wetter regions, whereas consecutive-dry-day (CDD) events lengthened by roughly ten days in the drier islands (Shaw et al., 2022). Seasonal cycle analysis shows the wet season beginning 5–15 days earlier in the west and ending 10–20 days later in the east, extending the overall rainy period but increasing inter-annual volatility (Ranashinghe et al., 2021).

At sea, the mean sea level rise (SLR) reached arround 4.3 mm yr^{-1}, exceeding the global average (3.7 mm yr^{-1}) (Shaw et al., 2022; World Bank, 2025). Rates surpass 5 mm yr^{-1} in Ambon and Merauke and arround ≈ 4 mm yr^{-1} along Java's north coast. Combined with local land subsidence (up to 5 cm yr^{-1} in Jakarta and Semarang), these trends translate into recurrent tidal flooding and saline intrusion. Changes in surface salinity (declines in the western Pacific warm pool (−0.05 psu yr^{-1}) and increases near the Java Sea (+0.03 psu yr^{-1})) alter regional currents and nutrient fluxes. Marine heatwaves (MHWs ≥ 5 days) now occur annually in the Banda and Arafura Seas, triggering mass coral-bleaching episodes (2010,

2016, 2020, 2023) (Beliyana et al., 2023; Habibullah et al., 2023; Ningsih et al., 2025; Saragih et al., 2025; Shaw et al., 2022). Figure 4.1 synthesises Indonesia's observed climate trends for 1991–2020, combining land-based and oceanic parameters in a single view. It depicts:

- Air temperature increases of +0.2 – 2.5°C across major islands;
- Rainfall anomalies ranging from –20% in southern regions to +20% in northern zones;
- Heat-wave frequency of 2–4 events per year in most islands;
- SST rise of +0.25 – 1°C since the 1980s and SLR rates of 4.3 mm yr^{-1}; and
- Spatial overlap between climate-extreme hotspots and documented disaster events (floods, droughts, cyclones, landslides).

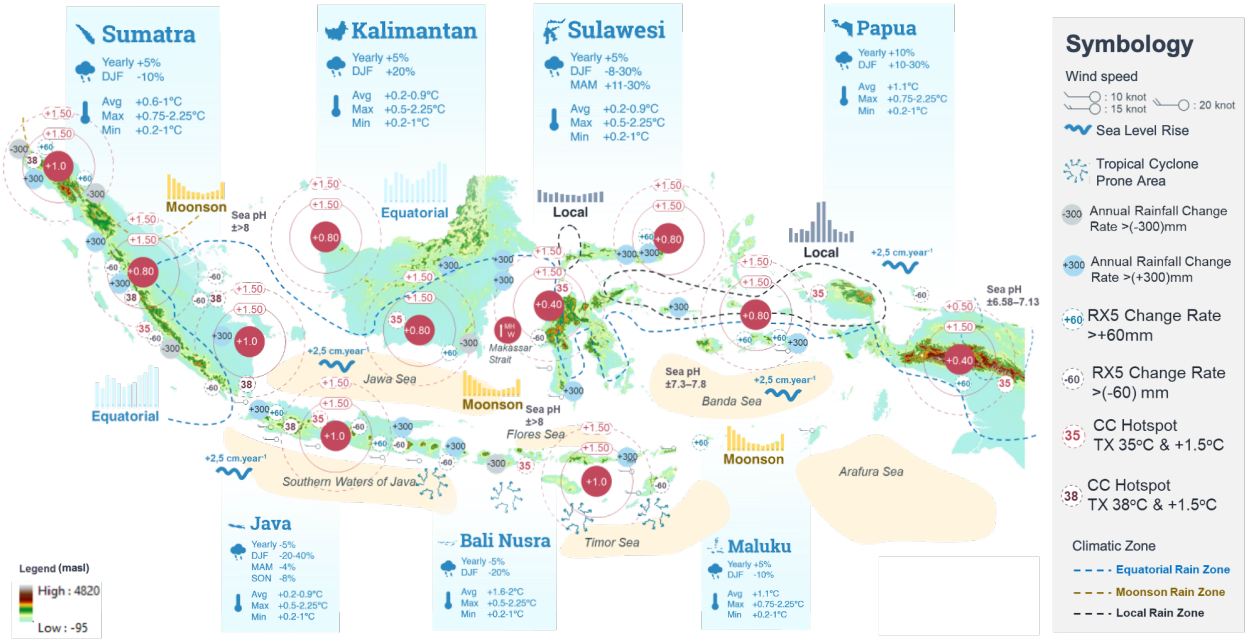


Figure 4.1 Observed Climate Trends (1991–2020). Composite map summarizing atmospheric and marine parameters from BMKG and national datasets (BTR Adaptasi, BMKG 2025). It illustrates spatial variations in temperature, rainfall, sea-surface temperature, and sea-level rise; identifies heat-wave frequencies and disaster hotspots; and demonstrates how land- and sea-based changes jointly shape Indonesia's climate risk profile.

Across islands, regions with decreasing rainfall (Java–Bali–Nusa Tenggara) coincide with SST-warming zones in adjacent seas, reinforcing drought intensity during El Niño events. Conversely, the increasing rainfall zones of Kalimantan and Sulawesi are linked to enhanced convective activity during La Niña phases. These atmospheric–oceanic interactions explain compound events i.e. drought (2015-2016, 2023–2024) followed by flooding (2007, 2010, 2020) (BNPB, 2021; BNPB, 2023; BPS, 2024; World Bank, 2016).

Table 4.1 Climate Parameter

Climate Parameter	Observed Trend (1991–2020)	Principal Implications for Chapter 5
Air Temperature	+0.81°C (↑ Tmax, Tmin)	Urban heat stress; crop yield decline; rising energy demand
Rainfall & Extremes	± 300 mm regional anomaly; ↑ Rx1day, CDD	Higher flood frequency (>80% regencies/ municipalities); drought recurrence in NTT and East Java
Sea Level	↑ 4.3 mm yr^{-1} average	Tidal flooding; coastal erosion; saline intrusion
SST & Salinity	↑ 0.2 – 0.3°C per decade; Δ salinity ± 0.05 psu	Coral bleaching; fisheries productivity loss; ecosystem stress

Box 4.1 – Compound Historical Climate Events in Indonesia (1991–2020)

Indonesia's climate history over the past three decades reveals how multiple hazards interact, compounding their impacts on people, ecosystems, and development. Three notable events illustrate these dynamics:

- El Niño 1997–1998
  - » Triggered severe droughts across Java, Kalimantan, and eastern Indonesia;
  - » Sparked widespread peatland and forest fires in Sumatra and Kalimantan, producing transboundary haze;
  - » Combined economic losses from degradation, haze, and carbon emissions were estimated at USD 5.1–6.3 billion, with major impacts on health, agriculture, and transport (BNPB, 2023).
- Jakarta Floods 2020
  - » Extreme rainfall of 377 mm in a single day compounded by land subsidence and inadequate drainage;
  - » BNPB reported 264 inundation points across 13 regencies/municipalities, with water levels up to 2.5 meter;.
  - » Economic losses reached IDR 1 trillion (BNPB, 2021).
- El Niño 2015–2016
  - » Extended droughts reduced harvests and water availability across Java, Sulawesi, and Nusa Tenggara;
  - » Peatland and forest fires reignited in Sumatra and Kalimantan, creating a haze crisis that caused severe public health impacts;
  - » Estimated losses exceeded USD 16 billion , with millions exposed to hazardous air quality (World Bank, 2016).

4.2 Projected Climate Futures

4.2.1 Future Temperature Trajectories and Extremes

Model ensembles indicate that the warming documented between 1991–2020 will not plateau but accelerate, driven by the cumulative effects of global greenhouse-gas accumulation and regional land-surface change. National mean temperature is projected to rise +1.0 – 1.5°C by 2050 under SSP 2-4.5 and +2.5 – 3.0°C by 2100 under SSP 5-8.5 (BMKG, 2025; IPCC, 2022a).

These projections are consistent across Indonesia's major planning frameworks. The NDC Roadmap (2020) first estimated +1.2°C by 2050 (RCP 4.5) and +2.4°C by 2100 (RCP 8.5). The Climate-Resilient Development (PBI) policy (Bappenas, 2021), refined these to +1.0–1.5°C (SSP 2-4.5) and +2.5–3.0°C (SSP 5-8.5), while the Biennial Transparency Report (2024) confirmed their validity through updated BMKG CMIP6/CORDEX-SEA ensembles. This alignment demonstrates the robustness and policy traceability of Indonesia's national temperature outlooks (Government of Indonesia, 2024a; IPCC, 2021).

Spatially, the same hotspots observed during 1991–2020 (Java, Sumatra, southern Kalimantan, Sulawesi, and Papua) remain the epicentres of projected warming. These are areas where deforestation, dense settlements, and rapid urban expansion amplify heat accumulation. Daily maximum and minimum temperatures are expected to rise at comparable rates, maintaining persistent nocturnal heat stress across urban lowlands. The frequency of hot-day events (Tx90p) is projected to double by 2050, while warm-night events (Tn90p) may triple by 2100, turning the episodic heat stress of the 2010s into a new climatic norm.

The underlying mechanisms include land-use feedbacks, declining vegetation cover, and regional aerosol interactions, ensuring that even under a moderate stabilization pathway, warming remains strongest over Java and eastern Indonesia (IPCC, 2022). These findings confirm a self-reinforcing continuation of the historical pattern, where atmospheric forces and local land-surface changes act synergistically. The thermal stress witnessed since 1991 is therefore not a temporary anomaly but a systemic trajectory that, if unmitigated, will define Indonesia's mid- to end-century climate (BMKG, 2025).

4.2.2 Projected Rainfall and Hydrometeorological Extremes

Indonesia's rainfall regime is projected to retain the north–wet / south–dry gradient that characterised 1991–2020, with amplified extremes and prolonged dry seasons (BMKG, 2019, 2022). This persistence arises from the same monsoonal and oceanic drivers—

notably ENSO, the Indian Ocean Dipole (IOD), and regional sea-surface temperature (SST) anomalies that governed past variability. Downscaled projections under SSP 2-4.5 and SSP 5-8.5 indicate that contrasts in rainfall across islands will sharpen, even though the national mean remains relatively stable (± 5"%). These findings are consistent with the NDC Roadmap (2020), the Climate-Resilient Development/PBI (2021), and BTR (2024), all of which confirmed the persistence of spatial divergence between wetter and drier zones. The three datasets collectively show that the mechanisms producing rainfall asymmetry in the historical baseline will continue to dominate Indonesia's hydro-climatic system throughout the century.

- Annual rainfall: near-stable nationally (± 5%), but regional contrasts intensify:
  - » Sumatra, Kalimantan, Sulawesi: projected to become wetter by +10% – 15%, driven by strengthened convective systems and enhanced moisture convergence;
  - » Java, Bali, and Nusa Tenggara: expected to become drier by –5% – 20%, reflecting continued subsidence, reduced cloud cover, and monsoon-shadow effects already observed in 1991–2020.
- Seasonal distribution:
  - » Wet-season (DJF) rainfall is projected to increase 5% – 10%, heightening flash-flood risk;
  - » Dry-season (JJA) rainfall is expected to decrease 15% – 25%, prolonging drought conditions and lowering soil-moisture recharge.
- Extreme indices: one-day maximum rainfall (Rx1day) increases 10% – 20%, while consecutive dry days (CDD) rise 15"% – 25"%, implying greater intra-seasonal variability.
- Seasonality: onset of the rainy season may advance by about 5 – 10 days, while cessation delays 10 – 20 days, effectively lengthening but destabilizing the rainy period.

These patterns confirm that the hydrological duality (simultaneous intensification of floods and droughts) will persist. Regions that historically faced compound drought–flood sequences, such as Java, Sulawesi, and Kalimantan, will remain vulnerable to alternating extremes. The projected intensification of rainfall variability demonstrates causal continuity: the same ENSO–IOD–SST interactions that produced hydro-climatic shocks in the past are expected to persist in the future.

As the PBI policy (2021) highlighted, these trends imply substantial adaptation challenges for water-resources management, irrigation scheduling and urban drainage systems. The continuation of rainfall asymmetry and seasonally compounded hazards underscores the need for dynamic early-warning systems, flexible agricultural calendars, and integrated basin-scale planning to maintain water security under increasingly erratic conditions.

4.2.3 Marine and Oceanic Projections

Projections for Indonesia's marine domain affirm the continuation and magnification of the oceanic trends observed during 1991–2020, confirming that the warming and sea-level rise recorded historically will persist throughout the twenty-first century. The PBI (2021) and Biennial Transparency Report (2024) both confirm that these modelled trajectories reproduce the spatial and temporal signatures of the 1991–2020 baseline. In all scenarios, Indonesia's seas remain among the world's fastest-warming semi-enclosed basins.

- Sea-surface temperature (SST): Projected to rise +0.20 – 0.30°C per decade, reaching +1.0 – 1.5°C by 2100 under SSP 5-8.5 (KLHK, 2021; Bappenas, 2018). The Banda, Arafura, and Java seas exhibit the strongest anomalies, mirroring the spatial pattern of historical SST hotspots and confirming continuity with observed warming trends (Kaczan et al., 2023; World Bank, 2025).
- Marine heatwaves (MHWs): Events that were sporadic during 1991–2020 (2–5 days per year) are projected to become annual to semi-annual by 2050 and may exceed 25 days per year by 2100, consistent with BTR 2024 ensemble outcomes (IPCC, 2019; Oliver et al., 2019). Longer and more frequent MHWs will severely stress coral and seagrass ecosystems, leading to mass-bleaching recurrence comparable to 2010, 2016, and 2020 (Habibullah et al., 2023).
- Sea level rise (SLR): The rate accelerates from the historical 4.3 mm yr^{-1} to arround ≈ 6 mm yr^{-1} by mid-century, yielding a cumulative rise of +0.25 – 0.35 m by 2050 and +0.60 – 0.70 m by 2100 under high-emission scenarios (Government of Indonesia, 2021; World Bank, 2025; IPCC, 2021; Hamlington et al., 2021; IPCC, 2019, 2023). The PBI 2021 and BTR 2024 both identify eastern Indonesia—Papua, Maluku, and Nusa Tenggara—as persistent SLR hotspots, while Northern Java experiences the greatest compound risk when local land subsidence is included (Aditiya & Ito, 2023; Andari et al., 2023; Handiani et al., 2022; World Bank, 2023)
- Salinity and currents: Projections indicate continued freshening in the western Pacific (−0.02 psu dec^{-1}) (IPCC, 2021) and a stronger Indonesian Throughflow, altering nutrient fluxes and primary productivity in the Banda and Arafura seas (Hamuna et al., 2018; Putriningtias et al., 2021; Rugebregt et al., 2023; Tito et al., 2023).These shifts will influence fishery distribution, plankton productivity, and carbon-cycle dynamics across Indonesia's Exclusive Economic Zone (Rajabson et al., 2023).

The ocean memory of past warming is long: even if global emissions stabilise, accumulated heat in the upper ocean layer ensures that Indonesian seas will continue to expand and warm through 2100. This thermal inertia means that coastal flooding, saline intrusion, and coral-reef degradation observed during 1991–2020 will evolve into chronic pressures unless adaptation measures (such as mangrove rehabilitation, integrated coastal zone management, and early-warning systems) are accelerated.

The convergence of international (NOAA, Copernicus) and national (BMKG, PBI, BTR) projections thus provides a robust, traceable foundation for Indonesia's NAP marine component. Collectively, these datasets affirm that the marine and atmospheric trajectories are synchronous: continued ocean warming and rising sea levels will compound terrestrial hazards, magnifying impacts on fisheries, coastal settlements and ecosystems throughout the archipelago.

4.3 Compound Futures and Continuity of Risk

Future hazard interactions are projected to replicate and intensify the compound patterns already evident during 1991–2020, confirming that Indonesia's multi-hazard landscape will continue to evolve along the same trajectories of interconnected risk. Ensemble results from BMKG (2025), integrated with national assessments in the NDC Roadmap (2020), the Climate-Resilient Development (PBI) policy (2021), and Biennial Transparency Report (BTR, 2024), all converge on a consistent picture: rising temperature, intensified rainfall extremes, and accelerating sea level rise are increasingly co-occurring in space and time, producing compound and cascading impacts across sectors.

1. Heat + Drought: The recurrent El Niño-related droughts of 2015–2016 and 2023–2024 provide analogues for future conditions. By 2050, these are projected to evolve into multi-season dry spells coupled with more frequent and longer extreme high temperatures, surpassing physiological and crop-tolerance thresholds. Both the NDC 2020 and BTR 2024 indicate that Java, East Nusa Tenggara (NTT), and southern Papua will experience the most persistent heat-drought combinations.

2. Flood + Landslide: In Sumatra and Sulawesi, where intense rainfall has historically triggered slope failures (2007, 2010, 2020), projected increases of 10%–20% in Rx5day indices will expand landslide-prone areas and shorten recurrence intervals. The compounding of prolonged wet spells with antecedent soil saturation raises the probability of cascading hydrometeorological disasters.

3. Sea Level Rise + Storm Surge: Chronic tidal inundation already observed along the North Java coast is expected to combine with higher wave run-up and storm surge intensity during monsoonal periods. By 2100, under SSP 5-8.5, mean sea level is projected to rise by 0.6 – 0.7 m, turning episodic flooding into permanent submergence zones in low-lying coastal districts.

Table 4.2 Compound Event in Projected Climate

Compound Hazard	Historical Evidence (1991–2020)	Projected Behaviour (2021–2100)	Supporting Source
Heat + Drought	Java and NTT (2015–16; 2023–24)	Longer, more frequent events by 2050	BTR 2024; NDC 2020
Flood + Landslide	Sumatra and Sulawesi (2007; 2010; 2020)	10% – 20% stronger Rx5day → higher slope failures	BMKG 2025; PBI 2021
SLR + Storm Surge	North Java coast	>0.6 m SLR → chronic tidal flooding by 2100	BTR 2024; PBI 2021

Although quantitative uncertainty remains moderate (around ± 0.3°C for temperature and ± 10% for rainfall) the magnitude of change far exceeds the uncertainty range, underscoring the robustness of these results. The persistence of identical hazard combinations across scenarios and documents demonstrates structural stability in Indonesia's risk profile: the types of hazards remain constant, but their frequency, duration and spatial overlap intensify.

These compound dynamics highlight the need for forward-looking, integrated risk governance. Multi-hazard early-warning systems, adaptive spatial planning, and cross-sectoral coordination will be essential to manage cascading risks that simultaneously threaten livelihoods, infrastructure, and ecosystems. As shown by the convergence of the NDC 2020, PBI 2021, and BTR 2024 findings, the continuity of risk chains from past to future confirms that Indonesia's adaptation priorities must shift from reactive disaster response towards anticipatory and transformational resilience building.

Tomia Island, Southeast Sulawesi © Ika R Suratno, GIZ, 2025

Box 4.2 – Translating Climate Signals into Adaptation Imperatives

Indonesia's adaptation priorities derive directly from the trajectory of its climate signals.

Observed baselines (1991–2020): Intensifying floods in the west and north, recurrent droughts in the southeast, and rising coastal hazards in northern Java already cause recurring losses equivalent to **0.61% of GDP annually** (Government of Indonesia, 2022b).

Projected futures (2021–2100):

- **Temperature rise:** +0.8 – 1.2°C by 2050 and >4°C by 2100 under high-emission scenarios (Government of Indonesia, 2024a).
- **Rainfall shifts:** +5% – 10% wet-season rainfall in Sumatra, Kalimantan, Sulawesi; –5 – 15% dry-season rainfall in NTT, Maluku, Papua (World Bank, 2025; Government of Indonesia, 2024a; IPCC, 2021)
- **Sea level rise:** 0.18 – 0.23 m by 2050, up to 0.8 – 0.9 m by 2100, and >1 m when subsidence is included (World Bank, 2025; IPCC, 2023; Government of Indonesia, 2021; IPCC, 2021; Hamlington et al., 2021; IPCC, 2019).
- **Marine heatwaves:** Increasing frequency in the Banda Sea and Raja Ampat, driving coral bleaching and ecosystem loss (Habibullah et al., 2023 IPCC, 2019; Oliver et al., 2019).

Adaptation imperatives:

- **Food security:** Resilient farming, efficient irrigation, and climate-smart agriculture;
- **Water resources:** Flood and drought management, watershed protection, and safe water access in small islands;
- **Energy systems:** Plan for higher cooling demand and secure hydropower under variable rainfall;
- **Health:** Mitigate risk of heat stress, infectious and non-communicable diseases, and child malnutrition;
- **Ecosystems:** Conserve and restore forests, mangroves, peatlands, and coral reefs.

Key Insight: Embedding these imperatives within the National Adaptation Plan moves Indonesia from recognising observed risks to implementing evidence-based, nationally owned, and internationally accountable action, fully aligned with the Enhanced NDC commitments and the ETF.

Prai Ijing Traditional Village, East Nusa Tenggara © Widhi, MoE/EPA, 2025

5

IMPACTS, VULNERABILITIES, AND RISKS

5.1 Overview of Climate Impacts on Development Sectors

Indonesia's socio-economic development is increasingly shaped by measurable shifts in its climate system. As detailed in Chapter 4, national mean air temperature has risen by about 0.81°C above the 1991–2020 baseline, with the projected increase reaching +1.2°C under SSP 2-4.5 and +2.5°C under SSP 5-8.5 by 2100 (BMKG, 2025; World Bank, 2025; BNPB, 2021; IPCC, 2021; KLHK, 2020). Rainfall remains highly variable: the frequency of daily extremes (>100 mm day^{-1}) has increased by 15%–20% in western and northern Indonesia, while eastern and southern islands experience prolonged dry seasons and severe drought during strong ENSO years. Mean sea-level rise averages 4.3 mm yr^{-1}, threatening low-lying coasts and estuaries with saline intrusion and recurrent tidal flooding (BMKG, 2025b; Government of Indonesia, 2024a). The combined evidence demonstrates that climate change already affects all five priority sectors of the National Adaptation Plan — food, water, energy, health, and ecosystem security — while Disaster Risk Management (DRM) functions as a cross-cutting enabler that links hazard information, early warning and emergency response (BMKG, 2025; Government of Indonesia, 2022b; IPCC, 2022a).

Across western Indonesia (Sumatra and Kalimantan), increasing rainfall intensity and higher temperatures (+0.8 – 1.2°C per decade) coincide with frequent urban-flood and heat-island events, averaging ≈ 137 extreme-rain days yr^{-1} (BNPB, 2018a). In Java and Nusa Tenggara, warming combined with rainfall deficits of 50–100 mm yr^{-1} has reduced rice and maize yields by 5%–30% , driven irrigation demand beyond design capacity, and lowered reservoir inflow by 10%–15%. Sulawesi and Maluku face increasingly erratic rainfall patterns that disrupt power generation and water supply, while Papua experiences the strongest ocean-warming signal (+0.04°C decade^{-1} sea-surface temperature (SST) rise) causing coral bleaching, mangrove retreat and coastal-habitat loss (De-Clippele et al., 2023; Prayitno et al., 2020; Handiani et al., 2022).

Energy and health sectors exhibit compounding vulnerabilities. Temperature anomalies of +1.0–1.5°C elevate electricity demand for cooling by 15%–30% and reduce hydropower output during drought years (ESDM, 2025; IEA, 2023). Concurrently, heat exposure and deteriorating air quality contribute to a 30%–50% increase in heat-related and vector-borne-disease incidence (Kemenkes, 2025; WHO, 2023). In peatland and forest areas, the same anomalies trigger frequent fire outbreaks, degrading biodiversity and emitting haze that intensifies respiratory illness.

Coastal and ecosystem vulnerabilities are magnified by the interaction between sea level rise and land subsidence, with relative elevation loss of 12–23 cm decade^{-1} recorded in northern Java and deltaic Sumatra (KLHK, 2020). Ecosystem degradation (forest loss, coral bleaching and seagrass decline) reduces ecosystem services vital for food production, water regulation and carbon storage, undermining the pathway toward the FOLU Net Sink 2030 target (KLHK, 2020).

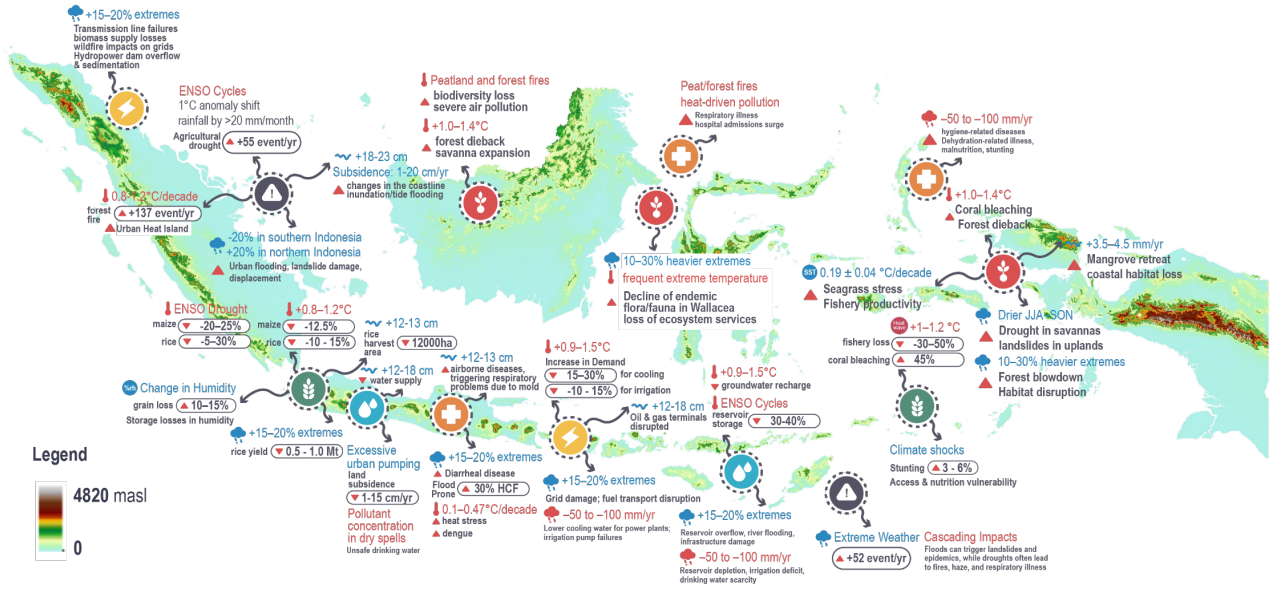


Figure 5.1 Spatial distribution of observed and projected climate-change impacts across Indonesia's five priority sectors, illustrating DRM as the enabling system connecting hazards and sectoral vulnerabilities. Source: BMKG (2025); compiled from sectoral ministry/agency inputs for the National Adaptation Plan.

Socio-economic exposure amplifies these physical risks. Approximately 60 million people live in multi-hazard zones where rising temperatures, water scarcity, and flood hazards intersect with high population density and infrastructure concentration. Urban areas such as Jakarta, Semarang, Surabaya, and Makassar exhibit compound risks of heat, flooding, and pollution, while remote provinces (such as East Nusa Tenggara, Maluku and Papua) face persistent infrastructure gaps and limited adaptive capacity.

Overall, the climate signals portrayed in Figure 5.1 establish the empirical foundation for the sectoral analyses that follow. Sections 5.2 to 5.6 detail how the evolving temperature, rainfall, and sea-level patterns quantified in Chapter 4 translate into specific biophysical and socio-economic impacts within each sector, while Section 5.7 elaborates on the enabling role of DRM in strengthening resilience across the national adaptation agenda.

5.2 Food Security

5.2.1 Observed Impacts

Indonesia's food systems — crops, livestock, fisheries and post-harvest chains are increasingly exposed to climate variability (Mangan & Siwek, 2024; Oke et al., 2024; Bezner Kerr et al., 2022; Thornton et al., 2021; Fernandez-Novo et al., 2020; Vandana et al., 2020). Observations during 1991–2020 show a national mean temperature rise of 0.8–1.2°C and irregular rainfall that disrupts planting calendars, damages crops, and increases pest outbreaks (KLHK, 2020; IPCC, 2022a; World Bank, 2021; USAID, 2016). Each +1°C rise corresponds to a 5%–10% reduction in rice productivity and 12% decline in maize yield (Amelework et al., 2021; Kengkanna et al., 2019; Moreno-Cadena et al., 2021), with 2024 production data showing –1.55% in rice output and –1.64% in harvest area compared to normal years (BPS and BRIN, 2025; BPS, 2024a; Kementan, 2024; World Bank, 2021).

Drought and flood extremes alternate across regions. Strong El Niño years (1997–1998, 2015–2016, 2023–2024) caused yield losses of 5%–30% for rice and maize (FAO, 2025; BPS and BRIN, 2024; BPN, 2023), while excessive rainfall events in Sumatra and Kalimantan increased flood damage and soil-nutrient depletion. These oscillations lower total agricultural growth by 0.2%–0.4% yr^{-1}, equivalent to 10%–15% of potential output. Fisheries and aquaculture production decline as sea-surface temperatures warm (+0.04 °C $decade^{-1}$) and ocean acidification increases, reducing coral health and coastal productivity (BPS, 2024d; KKP, 2024; Kennedy et al., 2020; IPCC, 2019; Oliver et al., 2019; Ampou et al., 2017).

To ensure consistency across sectors, the assessment of food-system vulnerability applies the Climate Risk Code (CRC) framework introduced in Chapter 3. The CRC system classifies each climate driver and its hazard into standardised codes linking measured variables, hazards, and impacts on production, storage, distribution, and access. Eight codes (F-01 to F-08) describe Indonesia's dominant climate pressures, summarised in Table 5.1.

Table 5.1 Climate Pressures and Impacts on Food Security

Code	Climate Parameter / Pressure	Specific Data	Climate Hazards	Data Type & Unit	Impacts on Food Systems (Production / Storage / Distribution / Access)	Geographic Hotspots
F-01	Temperature rise	0.8–1.2°C (1991–2020); +1.6–1.9°C by 2051–2080 (BMKG)	Heatwaves and heat stress	°C anomaly	Maize -12.5%; rice production –1.55% and harvest area –1.64% (BPS and BRIN, 2024); reduced yield for rice, maize, soybean; poultry mortality increase (Mangan and Siwek, 2024), aquaculture loss	Java, East Nusa Tenggara, South Sulawesi
F-02	Erratic monsoon onset and rainfall extremes	Delayed onset (+1 month); +15%–20% extreme rainfall since 1990s (BMKG 2024)	Floods, planting disruption	% rainfall anomaly	Shifted planting calendar (March→April); crop rot and vegetable losses (BPS and BRIN, 2025), aquaculture, Pests and plant diseases.	Java, Kalimantan, Sumatra
F-03	ENSO droughts	Major 1997–1998, 2015–2016 events	Drought / water deficit	SPI index /% rainfall anomaly	Rice –8.8% (1998); maize –5.75% (1997); cassava reduction and soybean imports↑ (Swastika et al., 2004).	East Nusa Tenggara, Maluku, Papua, East Java
F-04	Sea level rise and saline intrusion	12–13 cm (1993–2020); projected 0.18–0.23 m by 2050	Tidal floods, salinisation	cm SLR / ha affected	≈ 12 000 ha rice paddies salinised; aquaculture pond abandonment; milkfish / shrimp loss (BPS, 2024d; Oelviani et al., 2024).	North coast Java, Southern Java, South Sumatra, West Nusa Tenggara, East Nusa Tenggara, Maluku
F-05	Marine heatwaves and acidification	Coral bleaching (1998, 2010, 2016); +1–1.2°C SST by 2050	Bleaching, fish mortality	°C SST anomaly / pH	≈ 80% of reefs at bleaching risk by 2030; fisheries production –35%; protein deficit 2–4 kg cap^{-1} yr^{-1} (KKP, 2024), aquaculture production decline	Southeast Papua, Banda Sea (Maluku), Sulawesi reefs, Karimunjawa (Java),Bali, Java, Sumatra, West Nusa Tenggara, East Nusa Tenggara
F-06	Storage losses from humidity and flooding	Humidity ±5%; seasonal floods	Floods and heat stress	% post-harvest loss	Grain loss 10%–15%; cold-chain failures for fish, meat, dairy (Bappenas, 2021b; Government of Indonesia, 2021).	Java, Kalimantan
F-07	Distribution disruption	Flooded roads / ports; storm surges	Floods and storms	Days disrupted yr^{-1}	Supply-chain delays; national rice price↑ 14.08% (2023), Horticulture commodities depletion	Jakarta, Makassar, East Java
F-08	Access and nutrition vulnerability	Climate shocks and price spikes	Price volatility and stunting	% food price rise /% stunting	Stunting↑ 3%–6% in East Nusa Tenggara and Papua; urban-poor food access decline.	East Nusa Tenggara, Papua, urban low-income households

The CRC table quantifies how climatic pressures manifest across Indonesia. For instance, F-01 (temperature rise) links +0.8–1.2°C anomalies to 12.5% maize losses and 1.5%–1.6% reductions in rice output; F-03 (ENSO droughts) associates rainfall deficits of 50–100 mm yr^{-1} with 8%–9% reductions in rice production; while F-04 (sea level rise & salinity) records about 12.000 ha of coastal paddies degraded. Flood driven disruptions (F-02) delay planting by up to one month, while F-06–F-07 highlight post-harvest and transport losses from humidity and storm damage, raising national rice prices by ≈ 14% in 2023. The compounded effect of these codes reflects an evolving pattern of multi-hazard stress on Indonesia's food supply chain, as visualised in Figure 5.1.

5.2.2 Projected Impacts and Sectoral Vulnerability

Future climate scenarios indicate that these risks will intensify. Under SSP 2-4.5, mean temperature is projected to increase by +1.2°C by 2050 and +1.9°C by 2100; under SSP 5-8.5, warming could exceed +2.5°C by century's end. Applying CRCs F-01 to F-03, national models project yield reductions of 13%–18% for rice**,** 15%–22% for maize and 8%–12% for soybean without adaptation. Irrigation demand may rise 10%–15%, expanding dry-season deficits by 12–18 cm in major irrigation systems such as Jatiluhur and Karang Kates.

ENSO frequency and intensity are expected to increase, lengthening drought periods and shortening planting windows. By 2050, the average onset of the monsoon may be delayed by 15–30 days, consistent with CRC F-02, which will further reduce multi-cropping potential. In flood-prone basins, CRC F-03 and F-06 indicate more frequent rainfall extremes (+20 mm $month^{-1}$) that damage harvests and storage facilities.

Coastal agriculture faces compound risks from CRC F-04 (sea-level rise) and F-05 (marine heatwaves). Projected SLR of 0.18–0.23 m by 2050 could inundate >20.000 ha of low-lying paddies in Demak–Pekalongan–Semarang, while warmer seas reduce nearshore fisheries productivity by up to 35%. Protein deficits of 2–4 kg $capita^{-1}$ yr^{-1} may occur in coastal provinces.The National Food and Nutrition Early Warning System (SKPG) is included as an enabling tool for adaptive response in food security management.

The resurgence of animal diseases such as Foot and Mouth Disease (FMD) and increasing zoonotic outbreaks underscore a growing climate-linked risk to livestock and, consequently, to food security. For instance, the government reported an FMD outbreak across 11 provinces with over 14,000 animals infected and more than 300 dead since December, noting that extreme weather changes affecting livestock immunity were a contributing factor (Reuters, 2025). Climate-driven stress on livestock systems through higher temperatures, increased humidity, heat waves, altered rainfall patterns and droughts can weaken animal health,

increase susceptibility to pathogens, and disrupt grazing and fodder availability. Studies in East Java have shown that climate change significantly affects livestock-based food security, particularly in dairy production systems (Winarno et al., 2024). The combination of emerging and re-emerging diseases, climate-related stressors on animal health and productivity, and the interconnected nature of livestock systems thus poses a critical risk to Indonesia's food security, especially for communities reliant on small-scale animal husbandry.

5.2.3 Regional Differentiation

Climate impacts on food security vary spatially according to agro-ecological and socio-economic conditions.

- Western Indonesia (Sumatra, Kalimantan): Wetter conditions and higher extreme-rainfall intensity (F-02, F-03) heighten flood risk, pest outbreaks, and nutrient leaching. Peatland and forest fires during prolonged dry periods still disrupt local agriculture.
- Central Islands (Java, Bali, Nusa Tenggara): Strong warming signals (+1.0–1.5°C) and recurring ENSO droughts (F-01, F-03) intensify irrigation dependency and yield variability. Urban-heat-island effects raise evapotranspiration losses by 5%–10% per season.
- Eastern Indonesia (Sulawesi, Maluku, Papua): Ocean warming and salinity intrusion (F-04, F-05) degrade coastal and small-island farming systems; coral bleaching and fisheries decline threaten protein availability and livelihoods

5.3 Water Security

5.3.1 Observed Impacts

Indonesia's hydrological systems are under increasing stress from rising temperatures, rainfall extremes, and sea level rise, resulting in intensifying flood–drought duality across its major islands (Pradesi et al., 2023). Observational data from BMKG indicate that the frequency of extreme-rain events (>100 mm/day) has increased by 15%–20% since the 1990s, while dry-season rainfall deficits have expanded by 5%–25%, especially in East Nusa Tenggara and Maluku. The contrast between excessive rainfall and prolonged dry spells reflects an emerging pattern of hydrological imbalance that affects nearly all major river basins.

Between 1991 and 2020, the national mean temperature increased by 0.81°C, accelerating evapotranspiration and surface-water losses, particularly in Java and Sumatra. The combined effect of warming and rainfall anomalies is evident in the declining base-flow of 30% of monitored rivers and 10%–15% reductions in reservoir inflows during dry years. Coastal aquifers face additional pressure from sea level rise averaging 4.3 mm yr^{-1}, resulting in salinisation of wells and aquaculture ponds along the northern Java coast (W-05).

Flooding remains the most frequent water-related disaster in Indonesia. According to BNPB (2025a), the 2024 floods in DKI Jakarta resulted in 463 fatalities and severe damage to 146 houses, while repeated inundation episodes in South Kalimantan and Central Java caused extensive infrastructure losses. These events exemplify the increasing exposure to rainfall extremes (W-01) and highlight the urgent need for resilient catchment and infrastructure planning. Conversely, ENSO-related droughts (W-03) notably in 1997–1998, 2015–2016, and 2023–2024 triggered widespread water shortages (Khairina & Widiarti, 2024; Novianti et al., 2022), reducing water availability in Java, Bali, and East Nusa Tenggara by up to 20 billion m^3 (Khalil et al., 2021).

These hydrological shifts collectively demonstrate that water insecurity in Indonesia is driven by multiple converging pressures include temperature rise, rainfall variability, sea level intrusion, and human over-extraction. To capture these linkages systematically, this assessment applies the Climate Risk Code (CRC) framework described in Chapter 3, which standardises each climate driver and its associated hydrological hazard**.** Table 5.2 summarises the eight dominant CRCs (W-01 to W-08) that represent the main pressures on Indonesia's water systems, combining observational records and scenario-based estimates from BMKG (2025), BNPB (2025a), and OECD (2023).

Table 5.2 Climate Pressures and Impacts on Water Security in Indonesia

Code	Climate Parameter / Pressure	Specific Data	Climate Hazards	Data Type & Unit	Impacts on Water Systems	Geographic Hotspots
W-01	Rainfall variability and extremes	+15%–20% extreme-rain events since 1990s; projected +10%–20% more by 2050 (BMKG, 2025; IPCC, 2023)	Floods, flash floods, landslides	% anomaly / mm day^{-1}	Reservoir overflow; river flooding —Jakarta 2024 event caused 463 fatalities and 146 houses damaged (BNPB, 2025a); widespread infrastructure losses	West Java, Central Java, South Kalimantan, DKI Jakarta, West Nusa Tenggara
W-02	Drought and dry season deficit	–25% to –5% rainfall decline per season in East Nusa Tenggara and Maluku; +5% increase in cumulative dry days (BMKG 2025)	Seasonal drought	SPI / % anomaly	Reservoir depletion, irrigation deficits, domestic water shortage, limited livestock drinking	East Nusa Tenggara, Maluku, Papua, Java, South Sulawesi, West Nusa Tenggara, Bali
W-03	ENSO cycles	Strong El Niño events (2015–2016, 2019, 2023–2024)	Multi-year droughts	SPI / reservoir% capacity	2015 drought reduced water availability ≈ 20 billion m^3 in Java–Bali–East Nusa Tenggara (Khalil et al., 2021); hydropower losses up to 15%	Java, East Nusa Tenggara, Sulawesi, Papua,

Code	Climate Parameter / Pressure	Specific Data	Climate Hazards	Data Type & Unit	Impacts on Water Systems	Geographic Hotspots
W-04	Rising temperature	+0.9 – 1.5°C (1991–2020); +0.8 – 1.1°C more by 2050 (BMKG 2025)	Heatwaves, high evapotranspiration	°C anomaly / % ET_o change	Higher irrigation demand (+10%–15%); declining ground-water recharge (Government of Indonesia 2024a)	Java, Sumatra, Bali
W-05	Sea level rise & salinisation	+2–18 cm since 1993; +37.5 ± 2.5 cm by 2050 (BMKG, 2025; KLHK, 2020)	Tidal floods, saline intrusion	cm SLR / ha impacted	Salinisation of aquifers and shallow wells; loss of coastal water supply (OECD, 2023)	Central Java Jakarta, East Java
W-06	Ground-water extraction stress	Excessive urban pumping >5 cm yr^{-1} subsidence (Aditiya and Ito, 2023)	Land subsidence	cm subsidence yr^{-1}	5–10 cm yr^{-1} subsidence in Semarang–Kendal–Demak; salt-water intrusion into aquifers	Java
W-07	Water-quality degradation	High pollutant loads during dry spells; elevated turbidity in floods	Floods and droughts	mg L^{-1} pollutants / NTU	Raw water; diarrheal outbreaks (Government of Indonesia, 2024a)	Jakarta, West Java, Banten, East Nusa Tenggara, North Sumatra, Lampung, Southeast Sulawesi, Papua, North Papua
W-08	Infrastructure vulnerability	Flood-damaged dams, pipes, pumps (OECD, 2023)	Floods, landslides	% damage yr^{-1}	Maintenance cost↑ 30%–50% by 2050; service interruptions in urban supply networks	Java, Sumatra, Sulawesi

5.3.2 Projected Impacts and Sectoral Vulnerability

Future climate scenarios show a clear amplification of these hydrological stresses. Under SSP 2-4.5, mean air temperature is projected to increase by 1.2°C by 2050 and 1.9°C by 2100, intensifying evapotranspiration and reducing groundwater recharge (W-04). Rainfall extremes are projected to increase by 10%–20%, producing higher flood peaks in western and northern Indonesia and expanding floodplain areas by 5%–10% (BMKG, 2025a; IPCC, 2023).

The W-01 and W-02 codes indicate that increasing rainfall variability will cause more frequent hydrological extremes: flood recurrence intervals shorten in Sumatra and Kalimantan, while drought severity deepens in Java and Nusa Tenggara. ENSO-related droughts (W-03) will reduce streamflow by 5%–12% in moderate years and up to 30% under high-emission conditions, threatening the reliability of irrigation and hydropower systems. The 2015 El Niño event already reduced hydropower generation in Java by 15%, and similar or worse impacts are projected to become the norm by mid-century.

Sea level rise (W-05) compounds the problem in coastal basins. BMKG (2025b) projects an increase of 0.18–0.23 m by 2050, threatening drinking water intakes, wells, and agricultural land in low-lying deltas. In Demak, Semarang, and Surabaya, aquifer salinisation already limits domestic water supply reliability (Supriyadi et al., 2021), while continued subsidence from excessive groundwater pumping (W-06) aggravates tidal flooding. Urban centers such as North Jakarta experience subsidence rates of 5–10 cm per year (Aditiya and Ito, 2023), accelerating the loss of freshwater aquifers (Ashillah et al., 2025; (Genter et al., 2022).

Water quality degradation (W-07) is a growing issue in both flood and drought conditions. During prolonged dry spells, pollutant concentrations rise due to reduced dilution, while flood events increase turbidity and pathogen contamination. These trends are associated with rising incidences of diarrheal and water-borne diseases in peri-urban and rural areas (Government of Indonesia, 2024a). Infrastructure vulnerability (W-08) compounds these risks: flood and landslide events cause repeated damage to pipelines, dams, and pumping stations, with projected maintenance costs increasing by 30%–50% by 2050 (OECD, 2023).

5.3.3 Regional Differentiation

Climate impacts on water resources differ significantly across Indonesia's regions due to diverse climatic and geomorphological conditions.

- Sumatra and Kalimantan (W-01, W-05)**:** Projected to experience a 10%–20% increase in extreme-rainfall frequency, causing more frequent floods, sedimentation, and infrastructure strain. The Musi and Barito river basins exhibit surging sediment loads that reduce reservoir storage capacity by 20%–40%.
- Java and Bali (W-02, W-03, W-04)**:** Experience the strongest temperature and water-demand increases, with cumulative groundwater depletion and drought recurrence. Seasonal deficits threaten irrigation reliability in the Brantas and Citarum basins, where industrial water use competes with agriculture.
- Nusa Tenggara (W-02, W-03)**:** Faces chronic water scarcity, with annual rainfall <1,500 mm and frequent drought-linked crop failures. Drinking water supply interruptions exceed 40 days per year in drought years.
- Sulawesi (W-01, W-08): Characterised by steep catchments and flash flood susceptibility. Sedimentation and flood damage have already impaired 15% of regional water infrastructure.
- Papua (W-05, W-07): Experiences saline intrusion and contamination in coastal wetlands, while inland watersheds face landslides and pollution from mining runoff.

5.4 Energy Security

5.4.1 Observed Impacts

Based on the historical climate conditions explained in Chapter 4, it is found that long-term warming, intensified rainfall extremes, and gradual sea level rise are increasingly influencing Indonesia's energy systems. These climatic shifts have altered hydrological regimes, reduced the reliability of water resources for hydropower and cooling operations, and heightened the vulnerability of coastal and transmission infrastructure (Harsoyo, 2010; World Bank, 2018). Drought episodes linked to El Niño have lowered reservoir levels and reduced hydropower output by up to 15%, while excessive rainfall and flooding have damaged substations, coal-transport routes, and renewable energy facilities. At the same time, rising temperatures have driven greater electricity demand for cooling in major urban areas, underscoring that climate variability now directly affects both the supply and consumption sides of the national energy balance (BMKG, 2025; ESDM, 2023).

Indonesia's current energy mix (about 40.56% coal, 16.62% natural gas, 28.14% oil, and 14.68% renewables) shows how differently each subsector experiences climate pressure. Hydropower, geothermal, wind, and solar installations are directly climate-sensitive, while fossil infrastructure faces indirect exposure from flooding, corrosion, and demand surges (Nugroho et al., 2018; Sektiawan et al., 2016). In the 2015–2016 and 2023–2024 drought years, reduced rainfall and higher evapotranspiration (E-02 and E-04) decreased reservoir inflows in Java and Nusa Tenggara by 10%–20%, forcing utilities to rely on diesel peakers (PLN, 2023). Conversely, flood disasters (E-01) in South Sulawesi and Sumatra damaged transmission networks and transformers, causing multiday outages and economic losses exceeding IDR 400 billion (ESDM, 2023).

Coastal energy infrastructure (E-05) is increasingly at risk. Refineries, LNG terminals, and coal ports in Cilacap, Balikpapan, Bontang, and Surabaya, all within five metres of mean sea level, already report recurrent inundation and salt-induced corrosion. Observed sea level rise of 4.3 mm yr^{-1} (Government of Indonesia, 2022a; IPCC, 2022a; World Bank, 2025), accelerates maintenance cycles and raises operational costs. Meanwhile, wind-turbine corrosion and solar panel degradation have been documented along Java's and Sulawesi's coasts, confirming that marine exposure now constrains renewable-energy reliability. To capture these interactions systematically, this assessment applies the Climate Risk Code (CRC) framework (see Chapter 3). The eight codes (E-01 to E-08) summarise the dominant climate pressures affecting Indonesia's energy systems, as shown in Table 5.3

Table 5.3 Climate Pressures and Impacts on Energy Security

Code	Climate Parameter / Pressure	Specific Data	Climate Hazards	Data Type & Unit	Impacts on Energy Systems	Geographic Hotspots
E-01	Rainfall variability and extremes	+15%–20% increase in extreme rainfall since 1990s (BMKG, 2025)	Floods, landslides	% anomaly / mm day^{-1}	Flooding of substations; erosion and sedimentation at hydropower intakes	Sumatra, Kalimantan, Sulawesi
E-02	ENSO drought and dry season deficit	5%–25% rainfall reduction; multi-year droughts (2015–2016, 2023–2024)	Drought	SPI / % rainfall anomaly	Hydropower generation loss up to 25%; cooling-water shortage	Java, East Nusa Tenggara, Sulawesi, Bali
E-03	Storm and lightning frequency	+10% storm events; higher lightning density (BMKG, 2025)	Storms, surges	Events yr^{-1}	Transmission disruption; transformer failure	Java, Sumatra, Sulawesi
E-04	Rising temperature	+0.8–1.2°C since 1991; +1.9°C by 2100	Heat stress	°C anomaly / % demand	Cooling-energy demand +15%–30%; thermal efficiency loss 0.5% °C^{-1}	Java, Bali, Sumatra
E-05	Sea-level rise and saline corrosion	+2–18 cm since 1993; +0.23 m by 2050 (BMKG, 2025b)	Tidal floods, corrosion	cm SLR	Inundation of refineries, LNG ports, coastal renewables	Cilacap, Balikpapan, Surabaya, Bontang
E-06	Infrastructure and pipeline stress	High temperature and corrosion exposure	Heat and corrosion	% equipment loss yr^{-1}	Line sagging, leaks, battery degradation	Java, Sulawesi
E-07	Demand surge due to heat stress	+15%–30% cooling energy increase (IEA 2023)	Heat stress	% load increase	Urban grid overload; power shortages during heat events	Jakarta, Surabaya, Medan
E-08	Energy–water nexus stress	Drought, sedimentation, reservoir loss	Drought and flood	% generation loss	Reduced hydro and geothermal efficiency; maintenance costs↑	Java, Sulawesi, Kalimantan

5.4.2 Projected Impacts and Sectoral Vulnerability

Future climate projections suggest intensifying stress across generation, transmission, and demand systems. Under SSP 2-4.5, mean temperature is projected to rise by +1.2°C by 2050 and +1.9°C by 2100; under SSP 5-8.5, warming may exceed +2.5°C. This warming directly influences energy efficiency and demand: for each +1°C increase, gas- and coal-plant efficiency declines by 0.3%–0.5%, while electricity demand increases by 5%–8% (E-04, E-07). Hydrological impacts remain the most critical for renewable energy. Reduced inflow and prolonged droughts (E-02) could cut national hydropower output by 15%–25%, while more frequent rainfall extremes (E-01) raise flood risks for dam intakes and powerhouses. Heavy rainfall in 2020 and 2024 caused turbine shutdowns and sedimentation in Sulawesi's Bili-Bili Dam, while the 2023 drought limited the PLTA Saguling hydropower plant to 60% capacity (Batubara et al., 2023; Bott et al., 2021; Situmorang et al., 2021). Sea level rise (E-05)

and coastal erosion further threaten energy infrastructure and transport. By 2050, projected sea level rise of 0.18–0.23 m could inundate low-lying refineries, LNG ports, and solar farms, particularly along Java's and Kalimantan's northern coasts. Salt-spray corrosion may reduce solar efficiency by 3%–5% and shorten turbine lifespan.

Energy transport and storage systems (E-06) also face physical stress. High temperature and humidity accelerate pipeline corrosion and battery degradation, while storm events increase outage frequency. The energy–water nexus stress (E-08) compounds vulnerability: competing water needs for hydropower, cooling, irrigation, and municipal supply reduce reliability during droughts. In 2015, water shortages reduced hydropower generation in Java–East Nusa Tenggara by 15%, while thermal plant cooling restrictions caused partial blackouts.

5.4.3 Regional Differentiation

Climate impacts on energy sector differ significantly across Indonesia's regions due to diverse climatic and geomorphological conditions.

- Sumatra and Kalimantan (E-01, E-05)**:** Frequent floods and coastal inundation disrupt coal transport, refineries, and transmission corridors; sedimentation at hydropower intakes reduces generation efficiency.
- Java and Bali (E-02, E-04, E-07): Highest population and power demand; thermal plants face drought-driven cooling shortages and urban heat–induced load spikes. Heatwaves in 2023–2024 raised electricity consumption by ≈ 28%.
- Sulawesi (E-01, E-06, E-08): Hydropower-dependent grids experience flood-related downtime and reservoir sedimentation; geothermal fields face access disruption during heavy rains.
- Nusa Tenggara (E-05): Coastal solar-wind hybrids encounter corrosion and salt deposition, lowering output.
- Papua and Maluku (E-08): Isolated diesel-based systems suffer logistics delays during extreme rainfall and landslides; limited grid connectivity amplifies vulnerability.

These regional disparities align with differences in electrification rates — above 98% in Java and Bali but below 80% in eastern Indonesia — demonstrating how climatic and infrastructural inequalities converge to shape energy risk profiles.

5.5 Health Security

5.5.1 Observed Impacts

The climatic patterns identified in Chapter 4 — particularly the sustained increase in temperature and more frequent heat anomalies — have begun to manifest clear public-health consequences across Indonesia. Warming of nearly one degree since 1991 has amplified heat stress in densely populated urban areas, as reflected in rising heat-index values during the 2023–2024 El Niño. Apparent temperatures in several cities exceeded 40°C, leading to a 15%–25% increase in hospital admissions for heatstroke and cardio-respiratory illness (BMKG, 2025; World Bank, 2025; Government of Indonesia, 2022b; KLHK, 2020). These observed data correspond to CRC H-01 and H-02**,** which capture the combined pressure of temperature rise and heat stress that reduces labour productivity and threatens vulnerable groups — especially outdoor workers, the elderly, and infants. Changes in rainfall regimes (H-03, H-04) compound these thermal risks. More intense rainfall (+15%–20%) expands mosquito-breeding sites, driving dengue and leptospirosis outbreaks that rise 20%–30% in high rainfall years. Flood-related drainage failure and contamination increase diarrhoeal and cholera incidence by 5%–8% annually (Government of Indonesia, 2024a). Conversely, drought and peat fire haze (H-05) degrade air quality: particulate matter concentrations in 2019 exceeded WHO limits by 400%, producing >900 000 respiratory cases across Sumatra and Kalimantan (UNICEF, 2023a, Hein et al., 2022).

Climate impacts also extend to health-service infrastructure (H-06)**.** More than 2 000 facilities are located within flood-risk zones, about 20% within 5 km of the coast (Klipper et al., 2021). Recurrent inundation damages diagnostic equipment and disrupts power supply, causing vaccine cold-chain failures and service suspension. During the 2020 Jakarta floods, three hospitals were forced to evacuate patients after backup generators failed — illustrating how physical hazards translate into immediate health-system disruption (Klipper et al., 2021). Indirectly, nutrition and mental-health stressors (H-07, H-08) emerge as downstream consequences of climate events. Crop losses and food-price spikes (FAO, 2025) (see Section 5.2) reduce dietary diversity, raising stunting rates 3%–6% in East Nusa Tenggara and Papua. Post-disaster trauma and displacement affect more than five million people each year, with increased prevalence of anxiety and post-traumatic stress disorder among women and children (Kemenkes, 2023, 2022).

Together, these observed patterns confirm that Indonesia's health vulnerabilities are shifting from isolated outbreaks towards systemic, climate-driven health insecurity. As summarised in Table 5.4, eight Climate Risk Codes (CRC H-01 to H-08) represent the key pathways through which climate pressures influence health outcomes nationwide.

Table 5.4 Climate Pressures and Impacts on Health Security

Code	Climate Parameter / Pressure	Specific Data	Climate Hazards	Data Type & Unit	Impacts on Health Systems	Geographic Hotspots
H-01	Temperature rise	+0.8–1.2°C since 1991; +1.9°C by 2100	Heat stress	°C anomaly / heat index	Heat stress, cardio-respiratory illness, occupational injury↑ 3%–6%, increasing mosquito vector reproduction and transmission	Java, Bali, Sumatra, South Kalimantan, West Papua, East Nusa Tenggara, Banten, Lampung
H-02	Heat stress / apparent temperature	Apparent T >40°C (El Niño 2023–2024)	Prolonged heat days	Heat-index / days > threshold	Increased hospitalisation; labour productivity loss.	Jakarta, East Java, North Sumatra
H-03	Rainfall extremes / floods	+15%–20% extreme rain (BMKG, 2025)	Floods / stagnant water/flash floods	% anomaly / mm day^{-1}	Vector range expansion; dengue and leptospirosis↑ 20%–30%, casualties, physical injuries, damage to health facilities (included WASH and sanitation infrastructure)	Sumatra, East Kalimantan, Java, Sulawesi, Papua, West Papua, East Nusa Tenggara, Banten, Lampung
H-04	Water contamination / drainage failure, unsafe WASH services,	High turbidity and pathogen load in floods	Floods	mg L^{-1} pollutant / NTU	Diarrheal ↑ 5%–8%,	Jakarta, West Java
H-05	Drought and air pollution	2015–2016 El Niño, 2019 fires	Drought / haze	μg m^{-3} $PM_{2.5}$	Respiratory infections; ≈ 36,000 / $decade^{-1}$. Tuberculosis, cardiovascular disease, allergy	Sumatra, Kalimantan, East Nusa Tenggara, Banten,
H-06	Health-facility exposure	2 000+ facilities in flood zones (Kemenkes, 2025)	Floods / sea level rise	% facilities at risk	Equipment damage; service disruption; cold-chain failure, health facilities access disruption, waste management disruption,	Sulawesi, Papua, Java
H-07	Food and nutrition stress	Yield loss + 5%–30% (Section 5.2)	Food insecurity	% stunting / nutrition deficit	Stunting↑ 3%–6%; micronutrient deficiency	East Nusa Tenggara, Papua, West Sulawesi, Southeast Papua, West Nusa Tenggara, Maluku
H-08	Disaster-related trauma and mental health	Post-disaster exposure >5 million people / yr	Floods, droughts / displacement	cases yr^{-1}	PTSD, anxiety, depression↑	Java, Sulawesi, Papua

5.5.2 Projected Impacts and Sectoral Vulnerability

Future projections indicate that without adaptation, all eight CRC-identified pressures will intensify by mid-century. Under SSP 2-4.5, mean temperature is expected to rise +1.2°C by 2050 and +1.9°C by 2100. The number of heat stress days could double, and urban heat alerts may reach 40–60 days per year (H-01, H-02). Heat-related mortality projected to

increase 3%–6% by 2050 among older and outdoor-worker populations. Rainfall extremes (H-03, H-04) will intensify vector-borne and water-borne disease cycles. Model simulations suggest dengue incidence could rise 20%–30% by 2050 as vector reproduction accelerates 11%–20% for each +1°C temperature increase. Meanwhile, droughts and haze (H-05) could extend respiratory-illness seasons and cause ≈ 36.000 premature deaths per decade.

Infrastructure exposure (H-06) remains a major vulnerability. Sea level rise of 0.18–0.23 m by 2050 will inundate low-lying hospitals along Java's north coast and eastern Sumatra. Flood-related power outages interrupt water supply and medical waste management, threatening both patient and staff safety. Heat-related cooling demand may raise hospital energy use by ≈ 10% per °C rise, linking health resilience directly to the energy sector (see Section 5.4). Nutrition and mental-health stresses (H-07, H-08) will deepen inequality. Without adaptive food-security and social-protection measures, under-nutrition could worsen 3%–6%, and psychosocial disorders following disasters could increase 40%–50% by 2050. Urban populations will face chronic heat and pollution exposure, while rural and eastern provinces will struggle with food and service deficits. Economic modelling estimates cumulative health-sector losses from climate change at IDR 120–180 trillion by 2050, driven by productivity loss, treatment costs, and facility damage — underscoring the need to integrate adaptation across the national health system value chain.

5.5.3 Regional Differentiation

Climate impacts on the health sector differ significantly across Indonesia's regions. Regional contrasts reveal overlapping exposure: western islands contend with heat and pollution, while eastern islands face undernutrition and limited access to care. Gender and poverty amplify these disparities, underscoring the need for locally differentiated adaptation measures.

- Western Indonesia (Sumatra, Kalimantan): Haze (H-05) and heavy rainfall (H-03, H-04) increase respiratory and vector-borne disease; the 2019 fires produced >900 000 upper respiratory tract infection cases.
- Java and Bali: High population density and temperature extremes (H-01, H-02) drive heat stress admissions; Jakarta recorded >30 heat alert days in 2024 with emergency visits up 25%.
- Sulawesi: Flood (H-04, H-06) disrupts hospital access in Gorontalo and South Sulawesi; landslides isolate communities.
- Nusa Tenggara and Maluku: Drought and water scarcity (H-05, H-07) cause sanitation failures and diarrhoeal outbreaks; stunting remains >30%.
- Papua: Warming and rainfall change has expanded malaria's altitude range ≈ 300 m since the 1990s (H-03); nutritional and psychosocial issues persist (H-07, H-08).

The CRC H-01 to H-08 assessment shows that climate change endangers Indonesia's health security through interacting stressors: heat, disease, respiratory and nutritional burdens, and infrastructure exposure. Temperature rise, rainfall extremes, and drought interlink across sectors, making health outcomes a sensitive indicator of national resilience. These risks intersect with water quality (Section 5.3), food security (Section 5.2), energy reliability (Section 5.4), and ecosystem services (Section 5.6).

The Ministry of Health (Kemenkes) has introduced climate-informed early warning systems for heat and vector-borne diseases and resilient facility design standards in high-risk districts. Simultaneously, the Ministry of Finance and Kemen PPN/Bappenas have included health-system resilience within climate budget tagging and the National Registry (SRN-PPI). Strengthening these links between surveillance, infrastructure, and finance will reinforce Indonesia's social and livelihood resilience pillar within the national food–water–energy–health–ecosystem nexus.

5.6 Ecosystem Security

5.6.1 Observed Impacts

Rising mean air temperature of +0.8 to 1.2°C since 1991 has intensified marine and terrestrial heat stress, triggering the responses identified under CRC EC-01 and EC-02 in Table 5.5. This warming produced widespread coral bleaching events in 1998, 2010, and 2016, reducing live coral cover by 30–50% in Raja Ampat, the Banda Sea, and North Sulawesi reefs (De-Clippele et al., 2023; F. Setiawan et al., 2017).

A 15%–20% increase in extreme rainfall frequency since the 1990s corresponds with CRC EC-04, driving soil erosion, sediment loading, and landslides in river basins such as the Citarum and Mahakam. These hydrological extremes reduce water quality, smother coral reefs downstream, and degrade riparian and freshwater habitats (KLH/BPLH, 2025). Conversely, ENSO-related droughts (EC-03) cause peatland drying and fire susceptibility (Parmesan et al., 2022); during 2015–2016, peat fires in Sumatra and Kalimantan emitted > 800 Mt CO_2e and destroyed 2.6 million ha of habitat (World Bank, 2016). Both extremes highlight the dual pressure of water surplus and deficit captured in Table 5.5.

Meanwhile, sea level rise averaging 4.3 mm per year and more frequent coastal storms (EC-05, EC-06) have accelerated mangrove retreat and shoreline erosion along Java's north coast, South Kalimantan, and Papua's Arafura shore. About 390.000 ha of mangroves have been lost since 1990, 70% of which coincides with zones of highest relative sea level rise (FAO, 2023; UNDRR and UNU-EHS, 2023; Bappenas, 2022; KLHK, 2021).These physical

changes alter estuarine salinity and reduce fish nursery productivity, as summarised in Table 5.5.

Finally, land-use change and fire synergy (EC-07, EC-08) magnify climate stress. Deforestation and catchment clearing intensify flood–drought cycles and fragment habitats, while recurrent peat and forest fires cause severe biodiversity loss and regional haze (KLH/BPLH, 2025; Bappenas, 2024). Collectively, these trends demonstrate that the climate pressures outlined in Chapter 4 have become dominant ecological drivers across Indonesia's terrestrial, freshwater, and marine systems. They are represented through the eight CRC codes (EC-01 to EC-08) summarised below.

Table 5.5 Climate Pressures and Impacts on Ecosystem Security

Code	Climate Parameter / Pressure	Specific Data	Climate Hazards	Data Type & Unit	Impacts on Ecosystems	Geographic Hotspots
EC-01	Temperature rise	+0.8–1.2°C since 1991; +1.9°C by 2100	Heat stress	°C anomaly	Coral bleaching; forest dieback; species-range shift	Eastern Indonesia reefs; Papua uplands
EC-02	Marine heatwaves / acidification	Heatwave frequency × 20–50 by 2100; SST +1°C	Marine heatwaves, acidification	°C SST anomaly / pH	Coral cover loss 30%–50%; fish mortality, Southward and deeper-water shifts of tropical species.	Sulawesi reefs, Bali
EC-03	Drought / reduced rainfall	–5% to –25% rainfall (East Nusa Tenggara/Maluku)	Drought	SPI / mm season^{-1}	Peat drying, wetland shrinkage	Sumatra, Kalimantan, East Nusa Tenggara
EC-04	Rainfall extremes / erosion	+15%–20% heavy rain	Floods / landslides	% anomaly / mm day^{-1}	Soil erosion, sedimentation, water turbidity	Java, Sulawesi, West Papua
EC-05	Sea level rise and tidal flooding	+0.18–0.23 m by 2050	Coastal inundation	cm SLR / ha lost	Mangrove retreat; wetland loss	North Java, Demak, Seribu Islands
EC-06	Storms and coastal erosion	Higher wave height and storm surges	Storms / erosion	m wave height	Shoreline retreat; habitat loss	East Nusa Tenggara, Maluku, North Sulawesi
EC-07	Land-use change synergy	Deforestation / catchment clearing	Floods / droughts	% forest cover change yr^{-1}	Fragmentation; species decline	Sumatra, Kalimantan, Papua
EC-08	Fire and smoke events	2015, 2019 fires; > 800 Mt CO_2e	Peat and forest fires	ha burned / t CO_2e	Biodiversity loss; air-pollution impact	Central Kalimantan, Riau, South Sumatra

5.6.2 Projected Impacts and Sectoral Vulnerability

Building on the observed evidence described in Section 5.6.1, future projections SSP 2-4.5 and SSP 5-8.5 show that Indonesia's ecosystems will face increasingly severe and nonlinear responses to continued warming, hydrological variability, and sea level rise. The same climatic parameters already altering ecosystem processes, such as temperature,

rainfall, and sea levels are expected to intensify beyond many species' adaptive limits. By mid-century, average air-temperature rise of +1.2°C will multiply coral-bleaching frequency by ten-fold, and by 2100 annual bleaching could become the norm (EC-01, EC-02). This heat stress will cause further coral mortality and reduce reef-associated fish biomass. On land, prolonged dry seasons (EC-03) will intensify peat oxidation and wildfire recurrence, increasing greenhouse-gas emissions and biodiversity loss across Sumatra and Kalimantan.

Sea level rise (EC-05) of 0.23–0.35 m by 2100 is expected to submerge large portions of mangrove forests, especially in North Java, South Kalimantan, and Papua's Arafura coast. Without adequate sediment accretion or space for inland migration, total mangrove loss could reach 15%–25% by 2050 (≈ 600,000 ha). This loss would reduce coastal wave buffering, increase erosion, and weaken blue carbon sequestration, reinforcing flood and livelihood risks already evident today.

Rainfall extremes (EC-04) and storm intensities (EC-06) will further reshape terrestrial and marine habitats. Enhanced erosion will elevate sedimentation in coral and seagrass ecosystems, compounding bleaching stress, while stronger cyclones will damage reefs and aquaculture infrastructure. Inland, landslide frequency could increase by 10%–20% in mountainous zones such as West Java, Sulawesi and Papua, threatening watersheds and protected forests.

The synergy between land-use change and climate stressors (EC-07, EC-08) is projected to amplify biodiversity loss and fragmentation. Species distribution models predict an upslope or poleward migration of 150–400 m for many endemic species by 2050, decoupling pollination networks and food web stability. Fire-prone landscapes are expected to expand across degraded peatlands, increasing regional haze and transboundary pollution events. These shifts threaten biodiversity targets and the ecological integrity of conservation areas. Economically, ecosystem-related climate losses (estimated at IDR 250–320 trillion by 2050) are driven by mangrove retreat, coral bleaching, and peatland degradation, leading to a decline in ecosystem services such as fisheries productivity, coastal tourism and hydrological regulation. The resulting degradation not only undermines biodiversity and economic stability, but also generates cascading social and livelihood impacts for both coastal and upland communities. Climate-induced ecosystem loss disproportionately affects farmers, fishers, women, girls and persons with disabilities through reduced productivity and forced displacement.

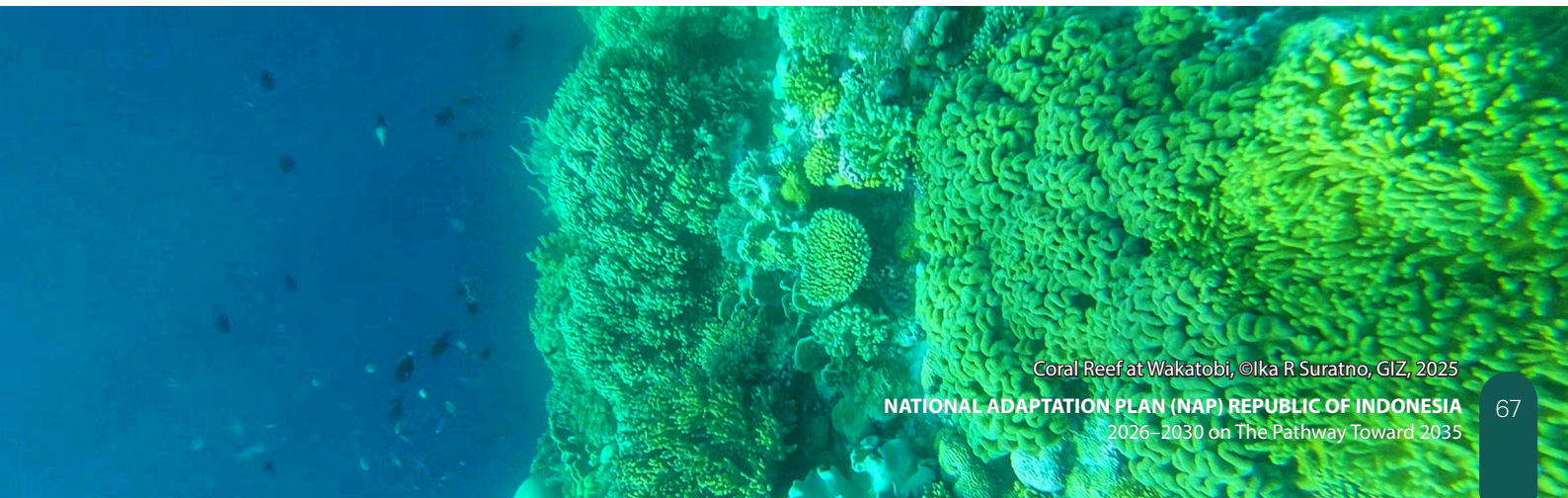
5.6.3 Regional Differentiation

The impacts of climate change on ecosystems differ by region in Indonesia. Regional differences mirror the climate and land-use gradients outlined in Table 5.5, highlighting that coastal zones face inundation and erosion while inland ecosystems confront fire, drought, and fragmentation.

- Sumatra and Kalimantan: Peat-drying and forest fires (EC-03, EC-08) lead to biodiversity loss and haze; wetland carbon stocks decline.
- Java and Bali: Sea level rise and coastal erosion (EC-05, EC-06) reduce mangrove belts and estuarine integrity; sediment from deforestation weakens reef resilience.
- Sulawesi and Maluku: Coral bleaching and storms (EC-02, EC-06) impact marine biodiversity and small-island economies.
- Nusa Tenggara: Drought and reduced rainfall (EC-03) drive savanna expansion and soil degradation.
- Papua: Warming and rainfall shift (EC-01, EC-04) alter montane biodiversity and accelerate mangrove submergence.

The CRC EC-01 to EC-08 assessment demonstrates that climate change has become a dominant driver of ecosystem transformation in Indonesia. Rising temperatures, altered rainfall, drought, and sea level rise interact with deforestation and land-use change, accelerating biodiversity loss and reducing ecosystem service capacity. These processes undermine resilience across food, water, energy and health sectors, making ecosystem-based adaptation (EbA) a national imperative.

The Ministry of Forestry (Kemenhut) and the Ministry of Environment (KLH/BPLH) have launched EbA and restoration programmes for mangroves, peatlands and coral reefs. The Ministry of National Development Planning (Kemen PPN/Bappenas) has embedded these initiatives within the Low-Carbon Development and Biodiversity Strategies, while the Ministry of Finance (Kemenkeu) identifies ecosystem restoration as a priority adaptation investment under SRN-PPI. Scaling and integrating these efforts will be essential to realise Indonesia's ecosystem and landscape resilience pillar within the national food–water–energy–health–ecosystem nexus.



Coral Reef at Wakatobi, ©Ika R Suratno, GIZ, 2025

5.7 Cross-Cutting Disaster Risk Management (DRM) Implications

Climate-related disasters remain the most visible manifestation of Indonesia's exposure to changing temperature, rainfall and sea level patterns described in Chapter 4. Yet, beyond immediate emergency response, disaster risk management (DRM) functions increasingly as an enabling system that supports adaptation outcomes across all sectors (food, water, energy, health and ecosystems). Over the past decade, Indonesia has advanced from reactive disaster response to a risk-informed governance model, institutionalised through the Disaster Management Master Plan 2020–2044 and the integration of adaptation priorities in the National Disaster Management Agency (BNPB) 2025 Strategic Plan / National Disaster Management Plan (BNPB, 2018b). These frameworks emphasise early warning capacity, resilient infrastructure, and risk-based financing as cross-sector levers for climate adaptation.

Indonesia's multi-hazard early warning architecture now links the Meteorology, Climatology and Geophysics Agency (BMKG) and sectoral agencies to deliver impact-based alerts that inform early action, with BNPB serving as the national lead agency for multi-hazard early warning systems, coordinating technical sectors and data providers to enable integrated disaster risk governance. The Geospatial Information Agency (BIG) supports multi-hazard early warning through tidal and CORS data networks integrated with the Indonesia Tsunami Early Warning System (InaTEWS). Systems such as InaTEWS for tsunamis and earthquakes, the Hydro-Meteorological Early Warning System for floods and droughts, and the Climate–Health Early Warning (CHEWS) platform jointly operated by BMKG and Kemenkes provide actionable lead times for local governments. Agricultural drought advisories issued by BMKG and the Ministry of Agriculture (Kementan) guide planting calendars and irrigation scheduling, while coastal flood bulletins enable the Ministry of Marine Affairs and Fisheries (KKP) and local fishers to adjust operations. These anticipatory measures embody the 'early warning to early action' approach promoted in the Adaptation Communication (2022) and represent a direct operational bridge between DRM and adaptation.

DRM also strengthens infrastructure resilience by embedding climate risk parameters into spatial planning and construction standards. The Ministry of Public Works (KemenPU) applies risk-informed design for water infrastructure, roads and housing through its *Guidelines for Climate-Resilient Infrastructure*. Disaster risk management in spatial planning now integrates land and marine domains through joint frameworks by KKP and the Ministry of Agrarian Affairs and Spatial Planning/National Land Agency (ATR/BPN) to mainstream climate and hazard risk into coastal zoning and infrastructure design. Marine spatial planning and coastal ecosystems such as seagrass and mangroves are recognised as natural infrastructure for disaster risk reduction and climate resilience. BNPB's *Safe*

School and Hospital initiative integrates structural safety audits with contingency plans to ensure functionality during floods, earthquakes or heatwaves. At the governance level, the Risk-Informed Development Framework (RIDF) under Kemen PPN/Bappenas links disaster-loss data with adaptation planning in SRN-PPI and national budget tagging. Fiscal instruments (contingency funds, catastrophe bonds, and disaster-insurance pilots) managed by the Ministry of Finance (Kemenkeu) provide financial buffers for recovery and adaptive reconstruction.

Post-disaster recovery is now guided by *build-back-better* principles that align with adaptation objectives, ensuring reconstructed assets exceed pre-disaster resilience standards. BNPB's Recovery and Rehabilitation Directorate coordinates with the Ministry of Environment (KLH/BPLH) and KemenPU to incorporate ecosystem restoration, green drainage, and coastal protection in recovery projects. Data integration between InaRISK, SRN-PPI, and ProKlim strengthens local adaptation evidence, while community-based initiatives such as Desa Tangguh Bencana (*Climate-Resilient Villages)* provide bottom-up entry points for participatory adaptation. These programmes demonstrate how DRM decentralisation enhances the social and livelihood resilience pillar identified in Chapter 6.

In summary, DRM functions as a horizontal enabler of Indonesia's adaptation architecture. By linking early warning, preparedness, infrastructure safety, financing and community-level governance, it operationalises climate-risk information into protective and preventive action. Its integration within national policy instruments (AdCom (2022) and BTR (2024)) ensures that disaster risk management underpins all three resilience pillars: economic, social-livelihood, and ecosystem-landscape resilience. Indonesia's DRM approach is shifting from reactive response to inclusive risk-informed governance, integrating gender and youth perspectives into city and regency/municipality-level contingency planning. This cross-sector functionality forms the institutional bridge to the synthesis of multi-sector impacts and regional hotspots discussed in Section 5.8.

5.8 Summary of Sectoral Impacts and Regional Hotspots

The evidence compiled in Sections 5.1 to 5.7 demonstrates that Indonesia's climate impacts are no longer isolated within single sectors, but occur through interconnected systemic pressures. Temperature rise, rainfall variability, sea level increase, and extreme weather events act together to disrupt production systems, public health, ecosystems and infrastructure. These interactions create compound and cascading risks, particularly where climatic, social and economic exposure overlap forming multi-dimensional regional hotspots of vulnerability.

5.8.1 Cross-Sectoral Patterns of Climate Impact

Across sectors, the rising mean temperature (+0.8–1.2°C since 1991) and increasing frequency of heatwaves are reshaping terrestrial and marine systems alike. In agriculture, higher evapotranspiration and erratic rainfall (CRC F-01, W-04) reduce yields and irrigation reliability, while in the energy sector they increase cooling demand and reduce hydropower generation. Sea level rise and saline intrusion (CRC F-04, W-05, EC-05) undermine coastal agriculture and freshwater supplies, while simultaneously driving mangrove retreat and aquaculture losses.

Rainfall extremes and floods (CRC F-02, W-01, H-03, EC-04) generate cascading effects — crop losses, infrastructure damage, and outbreaks of water- and vector-borne diseases. Conversely, drought and dry season deficits (CRC F-03, W-02, EC-03) reduce crop and fish productivity, deplete reservoirs, and heighten peat fire and haze incidents. These interlinked impacts collectively weaken food security, public health and ecosystem functions (BMKG, 2025; BNPB, 2025).

The health and ecosystem analyses (Sections 5.5 and 5.6) show how heat, air pollution and habitat degradation amplify one another, reducing labour productivity, biodiversity and ecosystem services. The combined findings from all sectors thus define a national climate-risk nexus linking economic, social-livelihood and ecosystem systems — an interdependence that forms the foundation for adaptation prioritisation in Chapter 6.

5.8.2 Regional Hotspot Distribution

The synthesis of CRC-coded sectoral impacts identifies five principal multi-sector hotspots where climate pressures and vulnerabilities converge:

- Java (Jakarta–Semarang–Surabaya): Sea level rise (EC-05), land subsidence and tidal floods affect urban settlements, ports and agriculture. Food and water security (F-04, W-05) are compromised by saline intrusion, while health facilities face flood exposure (H-06). Economic losses concentrate in industrial and coastal zones.
- Kalimantan and Sumatra: High rainfall variability and peat fires (EC-03, EC-08) degrade ecosystem services and emit large carbon fluxes. Drought–flood alternation disrupts agriculture (F-03, W-01) and rural livelihoods, while haze impacts public health.
- Sulawesi region (South, Central and North Sulawesi): Extreme rainfall and landslides (W-01, EC-04) affect mountainous catchments in South and Central Sulawesi, while marine heatwaves and storms (EC-02, EC-06) damage coral reefs and coastal fisheries in North Sulawesi. Flood events in Gorontalo and Makassar have disrupted water infrastructure and health services (H-03, H-06), illustrating cross-sector vulnerability.

- Nusa Tenggara (East Nusa Tenggara/West Nusa Tenggara): Drought frequency and prolonged dry seasons (F-03, W-02, H-07) reduce food availability, water storage and nutrition levels. Rising temperatures intensify heat stress on communities and livestock.
- Papua and Maluku: Warming trends (EC-01) and rainfall shifts (EC-04) alter montane forests and biodiversity, while coastal ecosystems (EC-05) face submergence. Health and nutrition vulnerabilities (H-07, H-08) remain high due to remoteness and limited access to services.

Table 5.6 Integrated Climate-Impact Hotspots and Linkages to Resilience Pillars

Region / Hotspot	Dominant Climate Pressures (CRC codes)	Multi-Sector Impacts	Affected Resilience Pillars
Java	F-04, W-05, EC-05, H-06	Tidal floods, saline intrusion, infrastructure damage, disease outbreaks	**Economic** (industrial and transport disruption); **Social-livelihood** (urban poor); **Ecosystem/ landscape** (mangrove loss)
Kalimantan and Sumatra	F-03, W-01, EC-03, EC-08	Peat fires, drought–flood alternation, biodiversity loss	**Ecosystem/landscape** (peat degradation); **Social-livelihood** (rural agriculture); **Economic** (production loss)
Sulawesi Region (South, Central and North)	W-01, EC-02, EC-04, EC-06, H-03	Floods and landslides in uplands; coral bleaching and coastal erosion; infrastructure and health system disruption	**Economic** (fisheries and transport); **Social-livelihood** (rural and coastal communities); **Ecosystem/landscape** (reef and watershed degradation)
Nusa Tenggara	F-03, W-02, H-07	Drought, water scarcity, nutrition decline	**Social-livelihood** (food and water access); **Economic** (agriculture); **Ecosystem** (dryland degradation)
Papua and Maluku	EC-01, EC-04, H-07, H-08	Biodiversity loss, rainfall anomalies, health and nutrition stress	**Ecosystem/landscape** (forest and reef systems); **Social-livelihood** (remote communities)

These cross-sectoral and spatial analyses confirm that Indonesia's climate risks emerge through compound, cascading interactions rather than isolated hazards. Regional climate extremes amplify systemic vulnerabilities; floods and sea level rise disrupt economic systems, drought undermines livelihoods; and ecological degradation weakens natural protection. The economic resilience pillar depends on safeguarding production, transport and energy infrastructure from hydrometeorological shocks. The social-livelihood pillar relies on protecting food, water and health systems from compounded heat, drought and flood stresses. Climate change further exacerbates social vulnerabilities such as disrupting education, healthcare for women and children, water provision for remote communities, and food security for indigenous groups, particularly during emergencies. The ecosystem and landscape pillar requires restoring mangroves, peatlands, and coral reefs that buffer physical hazards and sustain livelihoods. Together, these pillars provide the analytical basis for integrated adaptation planning in Chapter 6, where hotspot-based priorities will guide national and subnational interventions to achieve measurable resilience outcomes by 2030.

Green open space in Sunter River buffer zone, Koja. © Piarea, 2025

6

ADAPTATION ACTIONS AND PRIORITIES (2026–2030 TOWARD 2035)

6.1 Overview of Sectoral and Thematic Adaptation Priorities

Indonesia's National Adaptation Plan (NAP) defines the national framework for implementing adaptation priorities based on the climate-impact and risk evidence described in previous sections. Building on the analysis of observed changes and projected trends for 2021–2050, the NAP establishes adaptation measures for the operational period 2026–2030 and extends these towards 2035 as a pathway consistent with the nation's long-term vision for 2045. This dual-horizon framing allows the NAP to function as both a near-term operational instrument aligned with the National Medium-Term Development Plan (RPJMN) 2025–2029 that was updated in Minister of Agrarian Affairs and Spatial Planning/National Land Agency Regulation No. 12/2025 (Permen ATR/BPN 12/2025) on the ministry's strategic plan and a strategic bridge towards climate-resilient development by 2035. The analytical foundation relies on the national climate projections issued by the Meteorology, Climatology and Geophysics Agency (BMKG), which indicate continued warming, intensifying rainfall extremes, and sea level rise under SSP 2–4.5 and SSP 5–8.5 scenarios – directly influencing food, water, energy, health and ecosystem security.

Adaptation priorities for 2026–2030 towards 2035 reflect national commitments under Presidential Regulation No. 110/2025 (Perpres 110/2025) on implementation of 'Carbon Governance', and Minister of Environment and Forestry Regulation No. 12/2024 (Permen LHK 12/2024) on NDC implementation. They operationalise the adaptation component of the Enhanced NDC (2022) and Adaptation Communication (2022) while providing an enabling structure for the Biennial Transparency Report (2024). The NAP thus serves as an integrated coordination mechanism connecting national ministries and sub-national governments in the formulation of climate-resilient development programmes. It supports the implementation of the Paris Agreement's adaptation goal and the Sendai Framework for Disaster Risk Reduction 2015–2030.

Climate considerations are embedded in spatial planning as stipulated in Government Regulation No. 21/2021 (PP 21/2021), which integrates carrying capacity and environmental limits at all planning levels. The plan recognises that adaptation cannot be pursued in isolation within individual sectors. Indonesia's NAP therefore identifies five interdependent security domains (food, water, energy, health and ecosystems) as the thematic anchors of the national adaptation agenda. Each represents a critical interface between climate stressors and socio-economic systems, together forming a cohesive resilience architecture. Food security ensures sustainable production and nutrition under variable rainfall and temperature regimes; water security sustains reliable quantity and quality for domestic, agricultural and industrial uses; energy security underpins economic productivity and access; health security protects human wellbeing from climate-sensitive diseases and heat stress; and ecosystem and environmental security maintains biodiversity and ecosystem services that regulate climate and support livelihoods. These domains overlap rather than operate as silos – their interconnections define Indonesia's adaptive capacity.

The prioritisation of adaptation measures follows the multi-criteria assessment methodology detailed in Chapter 3, combining scientific evidence, policy relevance and feasibility. Risk indicators from BMKG climate datasets, Statistics Indonesia (BPS) socio-economic statistics, and spatial analyses from the Ministry of Environment (KLH/BPLH) and the Ministry of National Development Planning (Kemen PPN/Bappenas) were complemented by qualitative inputs from ministerial consultations and multi-stakeholder FGDs in 2024–2025. Through this iterative process, adaptation options were ranked according to urgency, transformative potential, and expected co-benefits across economic, social and ecological dimensions. The resulting portfolio aligns with the National Long-Term Development Plan (RPJPN 2025–2045), ensuring that actions undertaken during 2026–2030 serve as stepping-stones toward a climate-resilient Indonesia, while delivering co-benefits that may contribute to emission reductions and sustainable development (Bappenas, 2025c; Government of Indonesia, 2024a).

Findings in Chapter 5 show that the most critical vulnerabilities emerge from compound and cascading risks among sectors. Agriculture depends on reliable water and energy supply; health outcomes are linked to food and water quality as well as temperature extremes; and ecosystem degradation amplifies disaster risks that affect livelihoods and infrastructure. Accordingly, the NAP's priorities are designed not only to address sector-specific vulnerabilities but also to strengthen cross-sectoral resilience nexuses, namely: (1) the *food–water–energy* nexus that underpins economic resilience; (2) the *food–water–health* nexus that shapes social and livelihood resilience; and (3) the *ecosystem–water–energy* nexus that supports landscape and environmental stability. These nexuses provide the organizing logic for the integrated adaptation portfolio presented later in Section 6.3.

Within this framework, Disaster Risk Management (DRM) is treated as an enabler across all sectors rather than a separate field. Early warning systems, climate-service platforms, resilient infrastructure, and social-protection instruments collectively reduce the exposure and sensitivity of vulnerable populations. This integrated approach follows National Disaster Management Agency (BNPB, 2018b) guidance and the Disaster Management Master Plan (RIPB 2025–2045), ensuring coherence between adaptation and disaster management agendas.

Implementation of these priorities relies on coordinated governance at multiple levels. At the national scale, KLH/BPLH serves as the UNFCCC focal point and leads overall policy integration, working with Kemen PPN/Bappenas for mainstreaming into development plans and with sectoral ministries - Kementan, Kemen PU, Kemen ESDM, Kemenkes, Kemenhut, and KKP - for technical delivery. Provincial and regency/municipal governments translate national priorities into local actions through RAD-API and ProKlim programmes supported by the MRV Adaptasi system. This vertical coordination ensures that adaptation interventions correspond to regional climate contexts, development priorities and community needs. Ecoregions provide the ecological foundation for defining adaptation actions, ensuring that carrying capacity and environmental limits inform sectoral and regional priorities.

Financing and resource mobilisation are critical to realising adaptation priorities for 2026–2030 towards 2035. The NAP promotes blended finance schemes that combine public funding, private investment and international climate finance to support implementation at national and local levels. In line with Indonesia's fiscal framework, domestic public funding remains and will continue to be the main source of adaptation finance, providing a stable foundation for sustained implementation, while international climate finance serves as a complementary and catalytic mechanism to enhance scale, innovation, and partnership. Within this framework, public budget allocations remain the primary source of adaptation financing, while climate budget tagging (CBT) and other expenditure tracking systems function as monitoring instruments to identify, record and assess planned and actual climate-related spending rather than as direct financing mechanisms. Access to international adaptation funds – such as the Green Climate Fund (GCF), Adaptation Fund (AF) and Global Environment Facility (GEF) – is facilitated through KLH/BPLH as the National Designated Authority (NDA). At the same time, domestic innovation and community-based initiatives serve as key drivers for localised adaptation and knowledge sharing. These financing arrangements and monitoring tools will be elaborated in the following sections as part of the operational and monitoring frameworks.

The adaptation priorities are organized under three overarching resilience pillars that form the backbone of the NAP: (1) Economic Resilience, maintaining productivity, market stability, and infrastructure reliability across food, water, and energy systems; (2) Social and Livelihood Resilience, ensuring human health, safety, and equity through inclusive,

gender-responsive and community-based approaches; and (3) Ecosystem and Landscape Resilience, conserving natural capital and biodiversity as the foundation of long-term sustainability. Each pillar integrates sectoral measures and cross-cutting enablers such as data, finance, technology and capacity development.

The dual-horizon framework of 2026–2030 towards 2035 provides adaptive management flexibility. Progress will be reviewed through iterative monitoring cycles embedded in the MRV Adaptasi system, consistent with the Enhanced Transparency Framework (ETF) under the UNFCCC. Outcomes from these cycles will inform subsequent NAP updates and contribute to future BTR submissions. This ensures that the NAP remains a dynamic instrument – responsive to emerging risks, evolving science and stakeholder feedback. By 2035, lessons and data generated through this process will strengthen Indonesia's long-term pathway towards climate-resilient, sustainable development.

In summary, Chapter 6 acts as the strategic bridge between the national risk assessment and the operational adaptation response. It translates multi-sectoral evidence into a prioritised set of adaptation measures structured around five security domains and three resilience pillars. The following sections (6.2 to 6.4) detail these measures, culminating in an integrated national adaptation portfolio for 2026–2030 towards 2035 that is operational, measurable, and aligned with Indonesia's national and global commitments.

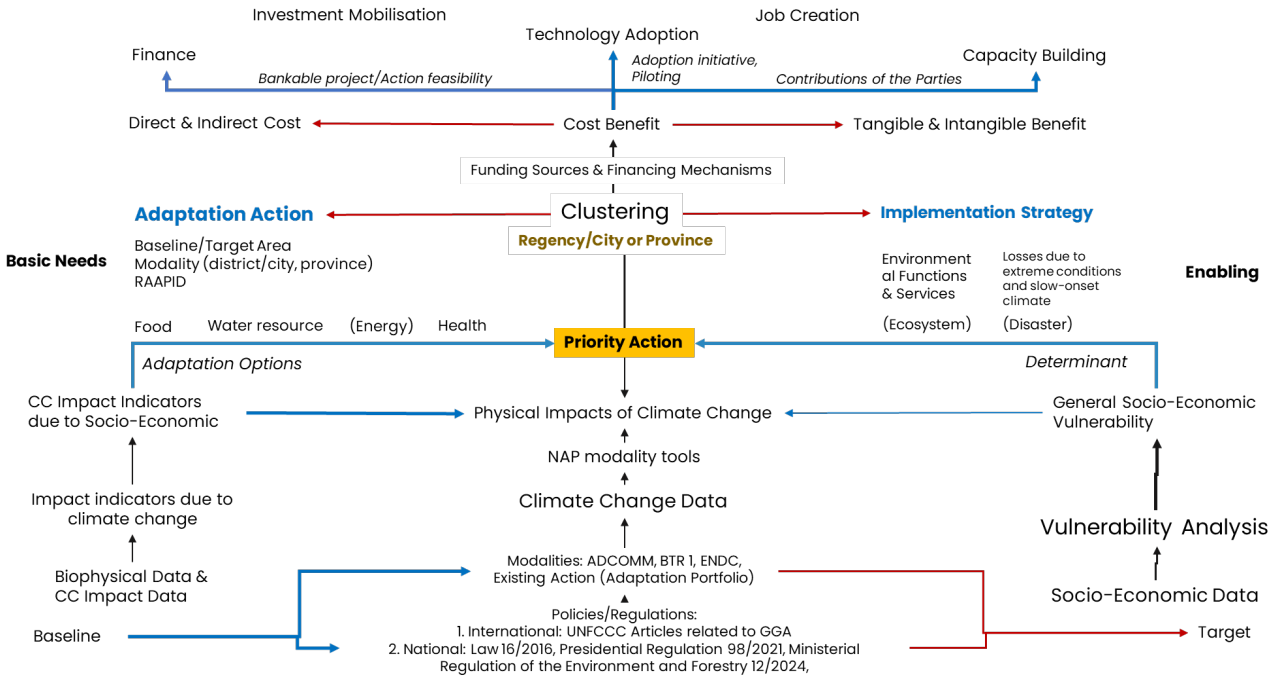


Figure 6.1 Conceptual framework linking climate impacts with sectoral and cross-sectoral adaptation priorities under Indonesia's NAP for 2026–2030 towards 2035.

6.2 Sectoral Adaptations

6.2.1 Food Security

Food security constitutes a central pillar of Indonesia's adaptation framework, as agriculture and fisheries directly sustain livelihoods, nutrition, and rural economies. Climate analysis for 2021–2050 shows clear evidence of temperature rise, rainfall irregularity, and prolonged dry seasons affecting the production of rice, maize, and horticultural crops in major breadbasket regions such as Java, South Sumatra, and South Sulawesi (BMKG, 2025; Government of Indonesia, 2024a). These changes intensify evapotranspiration and soil-moisture deficits, while extreme rainfall increases flood and pest outbreaks. The vulnerability of smallholder farmers, who form over 80 percent of the national agricultural workforce, places food security at the intersection of adaptation, poverty reduction, and social resilience.

The sectoral adaptation approach therefore seeks not to re-list technical actions, but to articulate a coherent transformation of Indonesia's agri-food systems into climate-resilient and inclusive systems capable of sustaining productivity under climatic uncertainty. The focus during 2026–2030 towards 2035 is threefold: securing production stability, improving access to climate information, and strengthening institutional and financial mechanisms that enable adaptive decision-making.

Food security adaptation measures are coordinated through the Coordinating Ministry for Food Affairs (Kemenko Pangan). A key adaptation rationale is the dependence of crop yields on hydrological variability. Coordination between food and water security planning is thus essential. Rehabilitation of irrigation networks, investment in small-scale water retention, and the integration of hydrometeorological forecasts into planting calendars form a continuous adaptation cycle connecting Kementan, Kemen PU and BMKG. Rather than enumerating specific technologies, the NAP emphasises the establishment of permanent feedback loops between farmers and climate service providers so that adaptive practices evolve with changing rainfall and temperature patterns (BMKG, 2025).

Another driver of adaptive capacity is diversification, both of crops and livelihoods. Diversification reduces exposure to single-commodity shocks and supports dietary quality. Promotion of drought-tolerant crops such as sorghum, cassava, and local tubers, alongside sustainable aquaculture and coastal fisheries, links adaptation with nutrition and income resilience. These measures are complemented by post-harvest and storage innovation, ensuring that climate variability does not translate into supply instability.

In the aquaculture sector, climate adaptation focuses on three complementary strategies: (1) species diversification to enhance tolerance to salinity, temperature and oxygen fluctuations – such as through saline-tolerant tilapia, milkfish and non-calcifying seaweeds (Gracilaria, Kappaphycus, Ulva) that help stabilise pH levels; (2) the adoption of solar-powered and Internet of Think (IoT)-based systems to monitor temperature and water quality in real time, replacing fossil-fuel-based generators with renewable energy; and (3) the use of automatic feeders to improve feed efficiency, reduce waste, and minimise indirect emissions from feed production. Furthermore, the climate-informed IPM (Integrated Pest Management) approach integrates weather forecasting, disease early warning systems, and ecosystem-based controls to prevent outbreaks of pathogens and parasites, thereby enhancing aquaculture resilience and productivity under changing climatic conditions. These innovations not only reduce vulnerability to fluctuating environmental conditions, but also support the transition toward low-carbon and climate-resilient aquaculture systems in Indonesia.

From an institutional perspective, adaptation effectiveness depends on inclusive governance. The agricultural extension system, local research institutions, and private agribusiness actors must jointly deliver adaptive technologies, while KLH/BPLH and Kemen PPN/Bappenas integrate monitoring indicators into the national MRV Adaptasi system. Stakeholder consultations and validation workshops held in 2025 highlighted that smallholder access to finance, land tenure security, and digital extension services are decisive enablers of long-term adaptation success (Bappenas, 2025; Kementan, 2025).

Disaster risk management (DRM) integration underpins this approach. Early-warning systems, climate risk mapping, and insurance mechanisms – such as Asuransi Usaha Tani Padi (AUTP) – are embedded within sectoral planning to buffer farmers from losses caused by floods, droughts and pests (BNPB, 2018b). These instruments transform reactive relief into proactive risk reduction, aligning food security adaptation with the National Disaster Management Master Plan (RIPB 2025–2045).

The temporal phasing of 2026–2030 towards 2035 provides flexibility for iterative learning. Initial years (2026–2028) emphasise capacity building, data harmonisation and pilot projects; the following years (2029–2030) focus on scaling proven measures through partnerships and incentive mechanisms; and the extension to 2035 consolidates integrated landscape management linking agriculture, water and ecosystems. The expected outcome is not merely higher yields, but enhanced system reliability, sustained farmer income, and stronger institutional collaboration that collectively define climate-resilient food systems.

Table 6.1 Summary of feasible adaptation measures for food security (2026–2030 towards 2035)

Code	Feasible daptation measure (operational detail)	Responsible Institutions	Code	Feasible adaptation measure (operational detail)	Responsible Institutions
FS-01	Drought- / heat-tolerant rice and maize varieties (Kementan, 2023, Wihardjaka et al., 2020), AWD irrigation, mulch/soil-moisture management (Rini et al., 2025), climate-smart planting windows	Kementan, BRIN, BMKG, Kemen PU, local governments, Kemenko Pangan	**FS-07**	Farm windbreaks (Enescu et al., 2025), cyclone-resistant livestock shelters, reinforced post-harvest storage	Kementan, local governments, BNPB (support), Kemenko Pangan
FS-02	Canal/drainage rehab (PUPR, 2024), flood-resilient varieties, smart gate control, raised beds in horticulture	Kementan, KemenPU, BBWS, Coordinating Ministry for Food Affairs	**FS-08**	Salt-tolerant rice, freshwater pond buffers, dike/sluice rehab, integrated rice–fish–mangrove systems	Kementan, KemenPU KLH/ BPLH, local governments, Coordinating Ministry for Food Affairs
FS-03	Climate-informed IPM; resistant cultivars; biocontrol/biopesticides; pest EWS with BMKG data; Cultivation technology supporting IPM	Kementan, BMKG, Local goverment, Coordinating Ministry for Food Affairs	**FS-09**	Hermetic storage; humidity-controlled silos; solar dryers (Lubis et al., 2024; Suryana et al., 2024)control, E1 and E2 did not reached the optimum temperature needed for drying paddy. The average temperature recorded at 3 different areas on surface insulator were 48.793°C (E1; aflatoxin screening; harvest timing advisory	Kementan; co-ops; BULOG partners, Coordinating Ministry for Food Affairs
FS-04	Weather-indexed crop insurance; bundled microcredit for CSA inputs; savings groups; rice farming business protection (AUTP) to protect rice farming businesses that experience crop failure due to floods, drought and pest attacks	Kementan, OJK, insurers	**FS-10**	Solar-powered pumps, gravity/pressurized piped systems, energy-efficient motors	Kementan, PUPR, ESDM, Coordinating Ministry for Food Affairs
FS-05	Conservation agriculture (Widyati et al., 2022); agroforestry; ameliorants; soil testing & advisory	Kementan, KLH/ BPLH; BRIN, Coordinating Ministry for Food Affairs	**FS-11**	Climate-proofed warehouses; decentralized cold rooms; all-weather feeder roads	Kementan, PUPR, Trade, local government, Coordinating Ministry for Food Affairs
FS-06	Nutrition-sensitive home gardens; diversified crops; agriculture–health linkage via Posyandu, diversified crops	Kementan, Kemenkes, Social Affairs, Coordinating Ministry for Food Affairs	**FS-12**	Heat-safe work protocols; shaded rest areas; hydration & scheduling; mechanization of peak-heat tasks	Kementan, Manpower, local gov'ts, Coordinating Ministry for Food Affairs

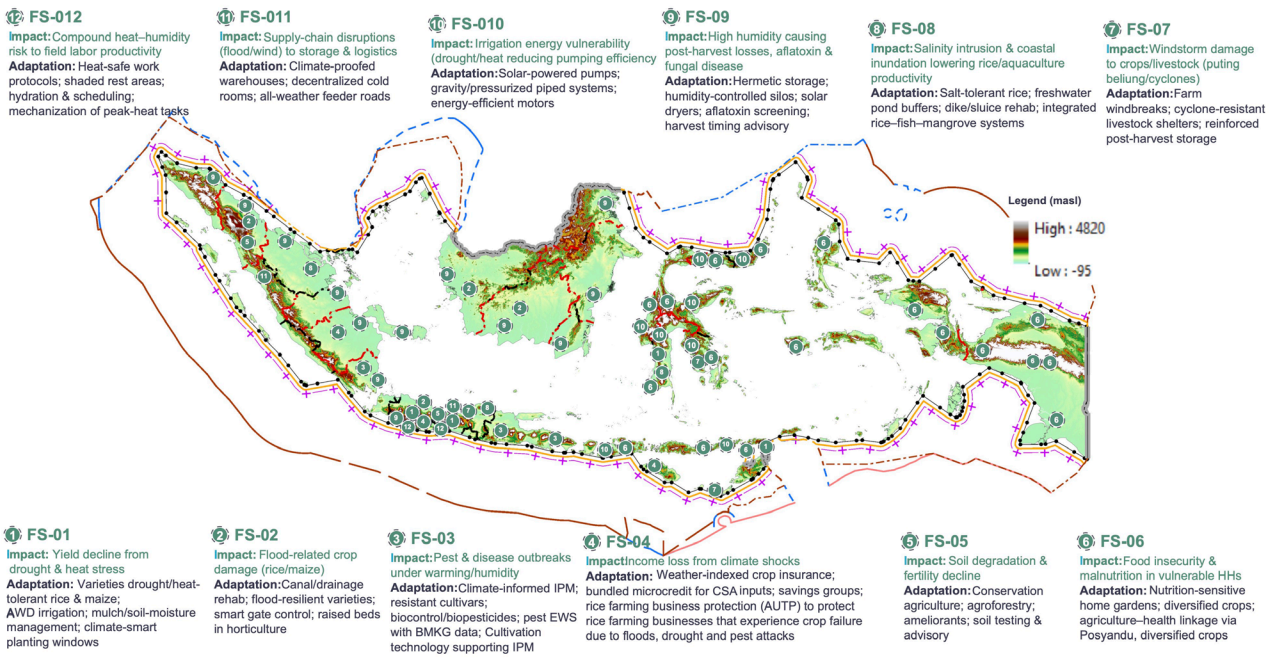


Figure 6.2 Proposed climate change adaptation action for the food sector across Indonesia considering impact and level of risk. Note: basemap constructed by administration boundary, protected rice field area at a scale of 1:50,000 and aquaculture area at a scale of 1:50,000. Small circles on the map indicate provinces for specific actions, while large circles indicate regions. Broken red lines show indicative provincial borders, while broken black lines show definitive provincial borders. Base map source: One Map Data – BIG, 2024

6.2.2 Water Security

Water security underpins Indonesia's entire adaptation framework, linking agriculture, settlements, energy generation, and ecosystem integrity. Climate projections for 2021–2050 indicate that seasonal rainfall will become increasingly erratic, with intensified wet-season peaks and prolonged dry-season deficits across most islands. Such shifts are already evident in declining river discharges during El Niño years and in flash-flood surges during La Niña episodes, both of which disrupt irrigation supply, domestic consumption, hydropower output, and water quality (Government of Indonesia, 2024a). These dynamics highlight the urgent need for adaptive management of surface and groundwater systems that balance competing uses among food production, urban demand, and environmental flows.

Indonesia's adaptation strategy for water security during 2026–2030 towards 2035 focuses on integrated water-resources management (IWRM) that connects infrastructure resilience, ecosystem services, and governance reform. Rather than listing every engineering project, the NAP emphasizes the shift from infrastructure expansion to climate-risk-informed operation and maintenance, ensuring that dams, reservoirs, and canals function under variable hydrological regimes. This requires climate data from BMKG to feed directly into reservoir-operation rules, drought-alert thresholds, and spatial planning by provincial water agencies. Co-management arrangements between river-basin organizations (BBWS/BWS) and local governments are being strengthened to enable adaptive allocation among agriculture, domestic, and industrial users.

A second strategic focus is water efficiency and demand management. Sectoral assessments show that agriculture accounts for roughly 70 per cent of national water withdrawals. Introducing micro-irrigation, rotational scheduling and precision watering – together with incentive mechanisms for efficient users – will increase resilience under reduced supply. At household and urban scales, promotion of rainwater harvesting, grey-water recycling, and low-flow technologies complements supply-side investments. These measures also generate co-benefits by reducing energy use for pumping and treatment, supporting the food–water–energy nexus highlighted in Section 6.1.

Ecosystem-based approaches provide the natural buffer of the water system. Watershed rehabilitation, reforestation of degraded headwaters, and peatland restoration are prioritized to restore infiltration and sediment-retention capacity. These interventions reduce flood and erosion hazards while maintaining base-flow reliability in dry months. Coastal and estuarine zones receive special attention through mangrove rehabilitation and sediment-trapping structures that mitigate saline intrusion and protect freshwater intakes. Integrating these nature-based solutions with engineered structures represents a cost-effective pathway consistent with international EbA (Ecosystem-based Adaptation) principles.

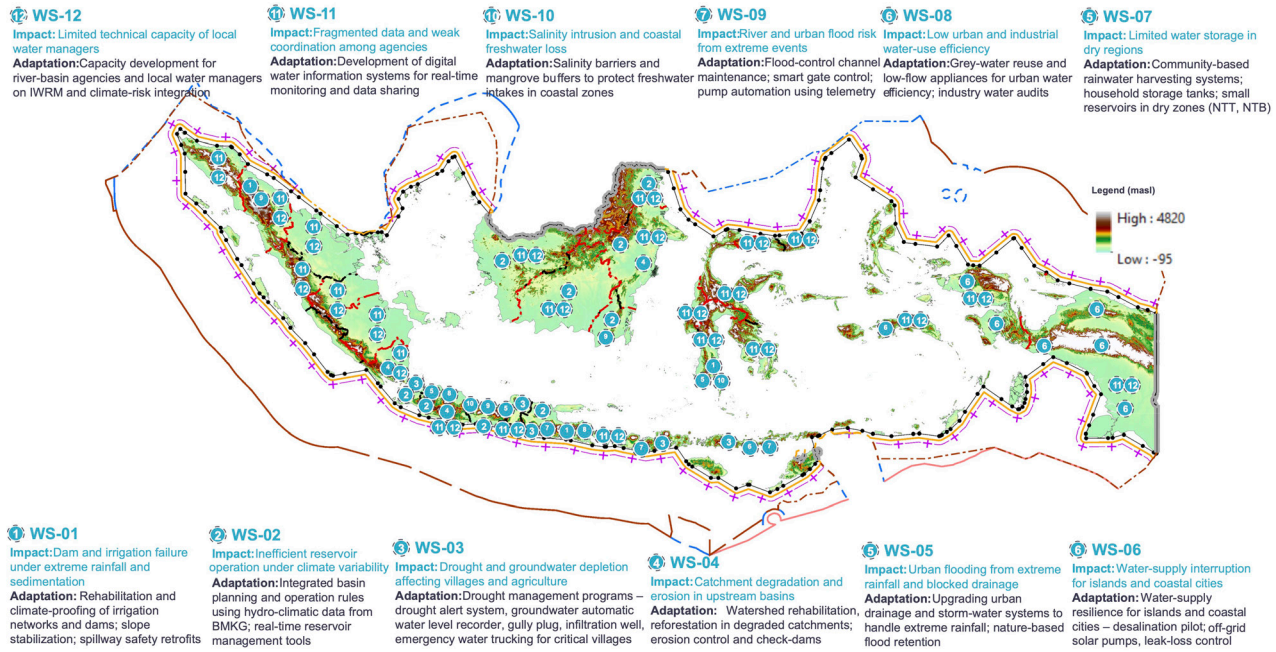


Figure 6.3 Proposed climate change adaptation action for the water sector across Indonesia considering impact and level of risk. Note: basemap constructed by administration boundary, primary irrigation network, area based on river basin condition, and area based on water availability. Small circles on the map indicate provinces for specific actions, while large circles indicate regions. Broken red lines show indicative provincial borders, while broken black lines show definitive provincial borders. Base map source: One Map Data – BIG, 2024

Institutional coordination remains a key enabling factor. The Ministry of Public Works (Kemen PU) leads technical planning and infrastructure development, KLH/BPLH coordinates climate-risk mainstreaming and MRV Adaptasi reporting, BMKG supplies hydro-climatic forecasts, while Kemen PPN/Bappenas ensures alignment with national development plans and financing frameworks. Provincial and regency/municipal water agencies implement local actions through river-basin or watershed plans that integrate adaptation targets. Stakeholder consultations in 2025 emphasised that local governments need capacity support in hydrological modelling, asset management and cross-jurisdictional coordination. Therefore, national programmes for data-sharing and digital water information systems are included as part of the adaptation package.

Financing of water-security adaptation combines central-budget allocations, public-service agency (BLU) revenues, and private-sector participation in water-supply and sanitation schemes. Blended financing, including results-based mechanisms under climate-budget tagging (CBT), will encourage performance-driven adaptation. At the same time, community-based initiatives such as Gerakan Cinta Sungai and Desa Air Bersih Tangguh Iklim provide social capital for monitoring and maintenance of small-scale infrastructure.

Disaster-risk-management elements are fully integrated into water-security planning. Early-warning systems for floods and droughts are expanded through the national hydrometeorological observation network, coupled with community-level dissemination and contingency planning (BNPB, 2018b). Critical infrastructure such as dams, intakes, pipelines, and treatment plants, will adopt resilience design standards addressing overtopping, scouring, and sedimentation hazards. Embedding these measures into the NAP ensures that risk reduction, service reliability, and ecosystem integrity are achieved simultaneously.

Paddy planting © Kemitraan, 2025

Table 6.2 Summary of Feasible Adaptation Measures for Water Security (2026 – 2030 Towards 2035)

Code	Feasible adaptation measure (operational details)	Responsible agencies	Code	Feasible adaptation measure (operational detail)	Responsible Aa
WS-01	Rehabilitation and climate-proofing of irrigation networks and dams; slope stabilisation; spillway safety retrofits	ESDM, Kemen PU, BBWS/ BWS; Local Government	**WS-07**	Community-based rainwater harvesting systems; household storage tanks; small reservoirs in dry zones (NTT, NTB)	Local Governments; Kemen PU; BMKG
WS-02	Integrated basin planning and operation rules using hydro-climatic data from BMKG, real-time reservoir management tools	Kemen PU, BMKG, KLH/ BPLH	**WS-08**	Grey-water reuse and low-flow appliances for urban water efficiency; industry water audits	KLH/BPLH, Kemen PU, ESDM, Kemenperin
WS-03	Drought management programmes – drought alert system, groundwater automatic water level recorder,gully plug, infiltration well and emergency water trucking for critical villages	ESDM, BMKG, BNPB, Kemen PU, Local Governments	**WS-09**	Flood-control channel maintenance, smart gate control, pump automation using telemetry	ESDM, BNPB, Kemen PU; BBWS/ BWS, BMKG
WS-04	Watershed rehabilitation and reforestation in degraded catchments, erosion control and check-dams	KLH/BPLH, Kemenhut; Local Governments	**WS-10**	Salinity barriers and mangrove buffers to protect freshwater intakes in coastal zones	KLH/BPLH, Kemen PU, KKP, Local Government
WS-05	Upgrading urban drainage and storm-water systems to handle extreme rainfall; nature-based flood retention	Kemen PU, Local Governments, BMKG	**WS-11**	Development of digital water information systems for real-time monitoring and data sharing	Kemen PU, BMKG, KLH/BPLH, Kemen PPN/Bappenas
WS-06	Water-supply resilience for islands and coastal cities – desalination pilots, off-grid solar pumps, leak-loss control	Kemen PU, ESDM, Local Governments	**WS-12**	Capacity development for river-basin agencies and local water managers on IWRM and climate-risk integration	Kemen PU, KLH/ BPLH, Kemen PPN/Bappenas, Universities

The phased implementation for 2026–2030 towards 2035 follows three sequential steps. The initial period (2026–2028) focuses on data harmonization, vulnerability mapping, and pilot projects in priority basins. The mid-term phase (2029–2030) expands rehabilitation and efficiency programmess, while the extension to 2035 consolidates institutional reforms and long-term financing models. By the end of this period, Indonesia aims to establish water systems that are adaptive, inclusive, and environmentally sustainable - providing reliable access for people, productive sectors, and ecosystems alike.

6.2.3 Energy Security

Energy is a foundational enabler of Indonesia's adaptation agenda, determining the resilience of food, water, health, and ecosystem systems. Rising temperatures, changing precipitation regimes, and more frequent extreme events have already begun to influence both energy demand and supply patterns. Higher ambient temperatures reduce thermal-plant efficiency and elevate electricity demand for cooling, while prolonged droughts

lower hydropower generation and threaten water-pumping capacity for irrigation and urban supply (BMKG, 2025; Government of Indonesia, 2024a). At the same time, storms and coastal flooding increase risks to fuel storage and transmission assets, especially in deltaic and island regions.

The overarching goal of Indonesia's energy-security adaptation during 2026–2030 towards 2035 is to maintain reliable, affordable, and climate-resilient energy services under variable and extreme climatic conditions. Rather than listing technological measures, the NAP emphasises system, level transformation, making energy planning, operation, and investment decisions responsive to climate information and risk assessment. This transformation links directly with the *food–water–energy* nexus described in Section 6.1, where resilient energy supply sustains irrigation, cold-chain systems and health infrastructure.

The first strategic direction concerns risk-informed energy-system management. Climate data produced by BMKG are integrated into energy resource assessments, reservoir operations, and grid stability models. This ensures that the design and operation of hydropower, transmission and fuel storage infrastructure account for shifting hydrological and temperature baselines. The Ministry of Energy and Mineral Resources (ESDM) coordinates with KLH/BPLH and Kemen PPN/Bappenas to institutionalise these risk assessments as part of investment appraisals and regulatory reviews.

Forest © UNDP Indonesia, 2025

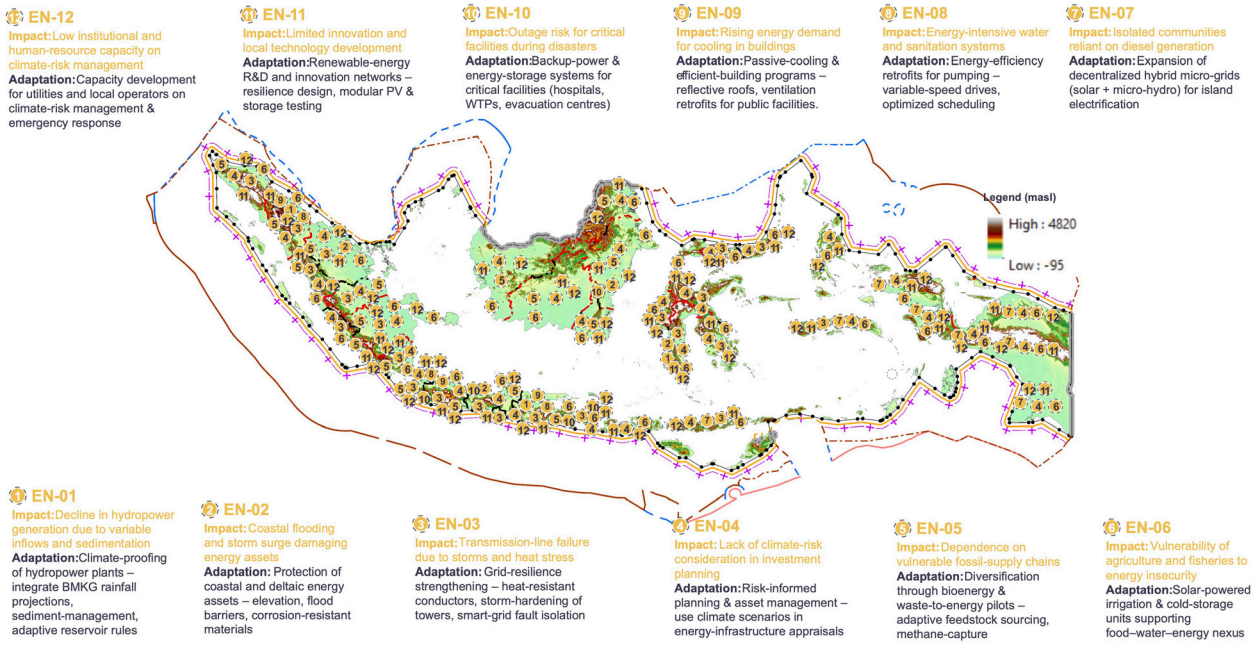


Figure 6.4 Proposed climate change adaptation action for the energy sector across Indonesia considering impact and level of risk. Note: basemap constructed by administration boundary, distribution of power plants and electricity network. Small circles on the map indicate provinces for specific actions, while large circles indicate regions. Broken red lines show indicative provincial borders, while broken black lines show definitive provincial borders. Base map source: One Map Data – BIG, 2024.

The second strategic direction is decentralisation and diversification. Indonesia's archipelagic geography makes centralised energy delivery inherently vulnerable to disruption. Decentralised systems, such as community-scale renewables and hybrid micro-grids – enhance resilience by shortening supply chains and reducing dependence on long transmission corridors. These systems also provide adaptation co-benefits to agriculture and water sectors through solar powered irrigation and cold storage, aligning with the food–water–energy nexus. The narrative focuses on enabling frameworks for such systems: governance mechanisms, financing instruments, and capacity building for local operators.

Third, energy-efficiency and demand management are recognised as adaptation imperatives. Efficient cooling technologies, building design improvements and energy management standards lower vulnerability to energy supply constraints while maintaining comfort and productivity in a warming climate. Efficiency gains in pumping and treatment facilities strengthen the resilience of both water and health services.

Cross-sectoral coordination ensures coherence and avoids redundancy of efforts. KemenESDM leads technical implementation, KLH/BPLH provides climate-risk screening and MRV Adaptation integration, and Kemen PU coordinates water-energy linkages for hydropower and irrigation systems. PLN, Pertamina and regional energy agencies

incorporate climate resilience criteria into asset management and emergency response plans. The stakeholder validation in 2025 highlighted the importance of consistent climate risk data, harmonised design standards and transparent coordination across sectors.

Financing mechanisms are designed to combine national budget allocations with renewable energy and green finance instruments. These include performance-based incentives for utilities adopting resilience standards and public–private partnerships for decentralised systems. At the local level, community energy funds and revolving schemes ensure operation and maintenance sustainability, supporting inclusion and long-term ownership.

Disaster risk management (DRM) integration remains cross-cutting. Early warning protocols for power system operation, emergency repair training, and backup supply for critical facilities (hospitals, water-treatment plants and evacuation centres) are embedded in corporate and public sector planning (BNPB, 2018b). Such preparedness measures safeguard essential services during crises and accelerate post-disaster recovery.

Table 6.3 Summary of Feasible Adaptation Measures for Energy Security (2026 – 2030 Towards 2035)

Code	Feasible adaptation Measure (operational detail)	Responsible institutions	Code	Feasible adaptation measure (operational details)	Responsible institutions
EN-01	Climate-proofing of hydropower plants – integrate BMKG rainfall projections, sediment-management, adaptive reservoir rules	ESDM, Kemen PU, Kemenhut, PLN, BMKG	**EN-07**	Expansion of decentralized hybrid micro-grids (solar + micro-hydro) for island electrification	ESDM, Local Government, PLN, BRIN
EN-02	Protection of coastal and deltaic energy assets – elevation, flood barriers, corrosion-resistant materials	Kemen ESDM, Kemen PU, KLH/BPLH, Pertamina	**EN-08**	Energy-efficiency retrofits for pumping – variable-speed drives, optimized scheduling	Kemen PU, Kemen ESDM, Water Utilities
EN-03	Grid-resilience strengthening – heat-resistant conductors, storm-hardening of towers, smart-grid fault isolation	PLN; KemenESDM, KLH/BPLH	**EN-09**	Passive-cooling & efficient-building programs – reflective roofs, ventilation retrofits for public facilities (Lawrence et al., 2020; Wenga et al., 2024)	ESDM, Kemen PU, Kemen Perkim, Local Governments
EN-04	Risk-informed planning & asset management – use climate scenarios in energy-infrastructure appraisals	Kemen ESDM, KLH/BPLH, Kemen PPN/ Bappenas, BMKG	**EN-10**	Backup-power & energy-storage systems for critical facilities (hospitals, WTPs, evacuation centres)	SDM, Kemen PU, BNPB, PLN
EN-05	Diversification through bioenergy & waste-to-energy pilots – adaptive feedstock sourcing, methane-capture	Kemen ESDM, KLH/ BPLH, Local Governments, Private Sector	**EN-11**	Renewable-energy R&D and innovation networks – resilience design, modular PV & storage testing	Kemen ESDM, Kemenhut, BRIN, Universities
EN-06	Solar-powered irrigation & cold-storage units supporting food–water–energy nexus	Kemen ESDM, Kementan, Kemen PU, Local Governments.	**EN-12**	Capacity development for utilities and local operators on climate-risk management & emergency response	Kemen ESDM, KLH/BPLH, PLN, Universities

The phased implementation for 2026–2030 towards 2035 follows a learning-by-doing approach. The first phase (2026–2028) prioritizes vulnerability assessment and pilot projects testing climate-resilient grid technologies; the mid-term (2029–2030) expands decentralized and efficiency programmes; and the extension (2031–2035) consolidates institutional and regulatory frameworks. The end-state is an adaptive and diversified energy system that can anticipate climate variability, sustain socio-economic productivity, and generate co-benefits for emission reduction without diverting the NAP's primary focus from adaptation.

6.2.4 Health Security

The stability of a nation's health system reveals how well it can adapt to crisis. Across Indonesia, the convergence of climate variability, environmental degradation, and urban pressure has begun to redraw the country's public-health landscape. More erratic rainfall, intense heat, and deteriorating air quality are reshaping disease transmission patterns and the conditions under which health workers operate. The increase of dengue outbreaks after anomalous rainy seasons, malaria resurgence in upland settlements, and spikes in respiratory illness during haze episodes are early signals that health risks are no longer bounded by geography or season (Kemenkes, 2025a, 2025b).

In this evolving context, adaptation is not simply about 'climate-proofing' hospitals – it is about transforming how the health system anticipates and manages risk. The NAP treats health as both a direct impact domain and a co-beneficiary of other adaptation pillars. Reliable water access, stable energy supply, and secure food systems all determine how well people remain nourished, hydrated and safe during climatic extremes. In that sense, health security becomes the ultimate indicator of adaptation success.

Indonesia's strategy for 2026–2030 towards 2035 begins by addressing vulnerabilities along the full chain of health delivery - from infrastructure and logistics to information and behavior. The first front line lies in resilient health infrastructure. Hundreds of *Puskesmas*, hospitals, and laboratories are located in flood-prone districts or heat-stressed cities. Retrofitting these facilities with elevated floors, improved drainage, efficient cooling, and backup power systems protects not only physical assets but also the safety of medical staff and patients. The Ministry of Health is embedding such standards into facility accreditation so that "resilience by design" becomes the norm rather than the exception.

A second and rapidly evolving front is information. The *Climate–Health Early Warning System (CHEWS)*, developed with BMKG and KLH/BPLH, translates rainfall, temperature, and air-quality forecasts into disease-risk bulletins that can trigger preventive action weeks in advance. These alerts link to the *Satu Sehat* digital platform, allowing provincial health offices to distribute advisories and pre-position medical supplies. The approach merges

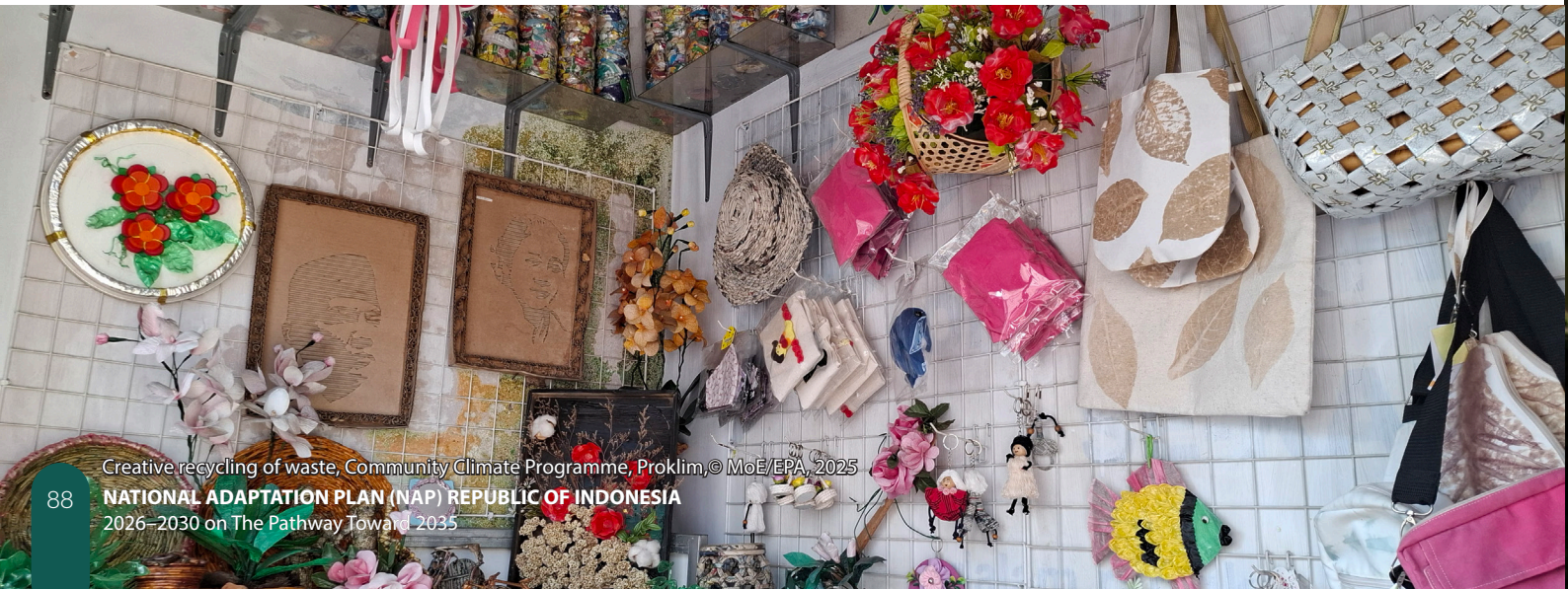
two previously separate worlds—meteorological data and epidemiological surveillance - creating a bridge between science and daily health practice.

Yet technology alone does not safeguard public health; communities do. Indonesia's adaptation framework invests heavily in community health resilience through initiatives such as *Desa/Kelurahan Sehat Iklim* and *Posyandu Hijau*. These programs train volunteers, women's groups, and youth to identify early disease symptoms, maintain clean water sources, and manage nutrition gardens that double as micro-adaptation hubs. By linking public-health promotion with environmental stewardship, local actors become sentinels of resilience, not just beneficiaries.

Behind these actions lies a deeper institutional reform: mainstreaming climate-risk awareness into the health bureaucracy itself. The 2025 consultations revealed that many health planners lacked access to localised climate data or risk-assessment tools. To close this gap, the NAP calls for climate-risk modules in the SIKELIM (environmental health system for climate and waste management), integration of adaptation indicators into budget tagging and joint training across the Ministry of Health, KLH/BPLH, and BMKG. Universities and professional associations are tasked to sustain this learning cycle through research and field internships.

Financing follows a layered logic. Core funding stems from the public-health budget, but adaptation components - such as CHEWS, resilient-facility retrofits, and climate-sensitive disease research - qualify for climate-finance channels. Partnerships with private hospitals, philanthropic groups, and the insurance sector create blended investment portfolios that spread risk while maintaining social equity.

Finally, health adaptation extends into crisis governance. Emergency drills now simulate compound events - floods combined with outbreaks or heatwaves during power failures. Revised SOPs for hospitals and supply chains ensure that critical services like dialysis, vaccination, and cold-chain management continue under extreme conditions (BNPB, 2018b). These procedures embody the principle of "adaptive continuity": learning from each event to rebuild stronger, not merely recover.



Creative recycling of waste, Community Climate Programme, Proklim,© MoE/EPA, 2025

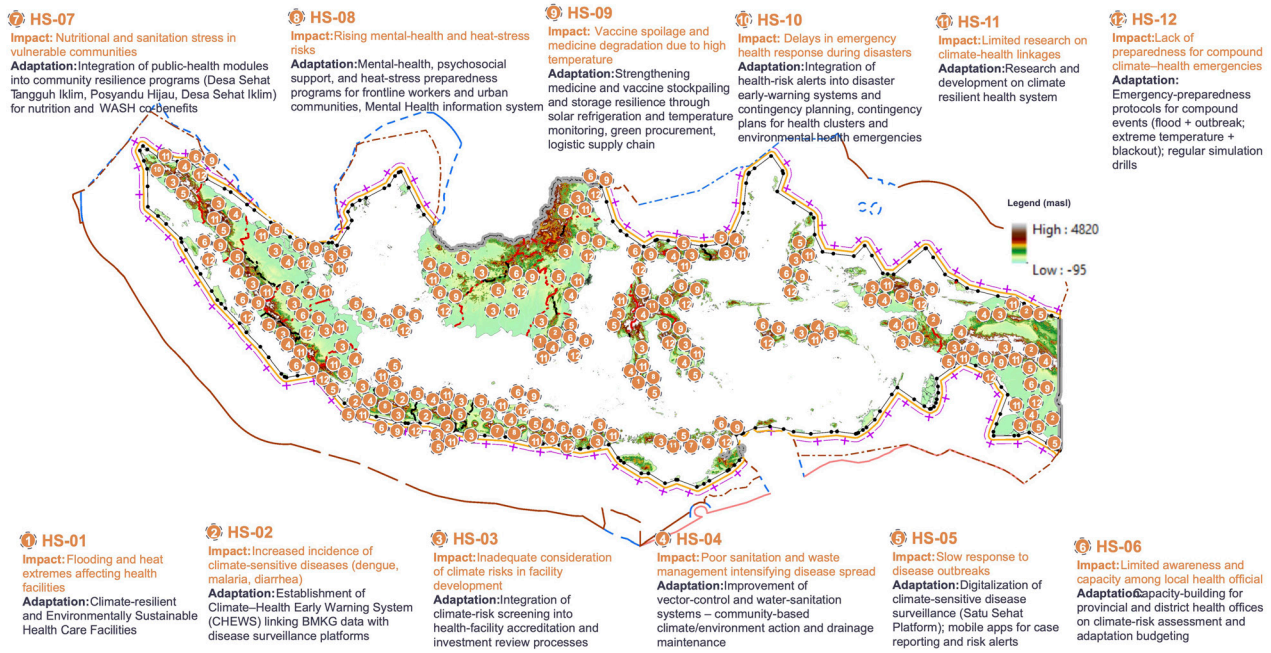


Figure 6.5 Proposed climate change adaptation action for the health sector across Indonesia considering impact and level of risk. Note: basemap constructed by administration boundary, classified precipitation areas (shade of purple), and distribution of low-cost rental apartments. Small circles on the map indicate provinces for specific actions, while large circles indicate regions. Base map source: One Map Data – BIG, 2024

Panthera tigris sumatrae, Harimau Sumatera © Indra Sugianto MoF, 2014

Table 6.4 Summary of Feasible Adaptation Measures for Health Security (2026–2030 Towards 2035)

Code	Feasible adaptation measure (operational detail)	Responsible institutions	Code	Feasible adaptation measure (operational detail)	Responsible institutions
HS-01	Climate-resilient and Environmentally Sustainable Health Care Facilities	Kemenkes, Kemen PU, KLH/ BPLH, Local Government	HS-07	Integration of public-health modules into community resilience programs (*Desa Sehat Tangguh Iklim*, *Posyandu Hijau, Desa Sehat Iklim*) for nutrition and WASH co-benefits	Kemendagri, Kemendes, Kemenkes, Kemensos, Local Governments, CSOs
HS-02	Establishment of Climate–Health Early Warning System (CHEWS) linking BMKG data with disease surveillance platforms	Kemenkes, KLH/BPLH, BMKG, Kemen PPN/ Bappenas	HS-08	Mental-health, psychosocial support, and heat-stress preparedness programs for frontline workers and urban communities, Mental Health information system	Kemenkes, Local Government, Universities
HS-03	Integration of climate-risk screening into health-facility accreditation and investment review processes	Kemenkes, KLH/BPLH, Kemen PPN/ Bappenas	HS-09	Strengthening medicine and vaccine stockpailing and storage resilience through solar refrigeration and temperature monitoring, green procurement, logistic supply chain	Kemenkes, ESDM, BUMN, Private Sector, Development partner
HS-04	Improvement of vector-control and water-sanitation systems – community-based climate/environment action and drainage maintenance	Kemenkes, Kemendes, Kemen PU, Local Government	HS-10	Integration of health-risk alerts into disaster early-warning systems and contingency planning (BNPB, 2018b), contingency plans for health clusters and environmental health emergencies	Kemenkes, Kemendagri, BNPB, BMKG, Local Gov't
HS-05	Digitalization of climate-sensitive disease surveillance (*Satu Sehat* Platform); mobile apps for case reporting and risk alerts	Kemenkes, KLH/BPLH, BMKG, Universities, Komdigi, BNPB	HS-11	Research and development on climate resilient health system	Kemenkes, BRIN, Kemendiktisaintek
HS-06	Capacity-building for provincial and district health offices on climate-risk assessment and adaptation budgeting	Kemenkes, KLH/BPLH, Kemen PPN/ Bappenas, Kemendagri	HS-12	Emergency-preparedness protocols for compound events (flood + outbreak, extreme temperature + blackout); regular simulation drills	Kemenkes, BNPB, Local Government, PLN

The timeline to 2035 is staged but cumulative. Between 2026 and 2028, focus rests on mapping vulnerabilities and piloting CHEWS in high-risk provinces such as East Nusa Tenggara, Central Java and South Kalimantan. The 2029–2030 phase scales up resilient-facility retrofits and integrates early warning data nationally. From 2031 to 2035, emphasis shifts to institutional permanence – embedding climate resilience into every layer of the health system. By that horizon, Indonesia envisions a health sector that not only survives the pressures of a warming world, but acts as a stabilising force for communities, embodying resilience in both structure and spirit.

6.2.5 Ecosystem Security

Indonesia's ecosystems (mangrove, seagrass, coral reef, peatland, forest, and agro-ecosystems) form the country's most enduring shield against climate risk. They regulate water flows, moderate temperature extremes, and provide food, energy and livelihoods for millions. Yet these same systems are also among the most vulnerable: intensified droughts trigger forest fires; sea level rise drowns mangroves and coastal forests; and unpredictable rainfall alters the rhythm of river and estuary life. In some provinces, like Riau and Central Kalimantan, repeated fire and haze episodes now overlap with flooding in the same landscapes, eroding both biodiversity and community resilience (Kemenhut, 2025; KLH/BPLH, 2025).

In Indonesia's NAP, ecosystem and environmental security serves as the 'ecological backbone' that supports all other adaptation sectors. The objective for 2026–2030 towards 2035 is not only to restore degraded landscapes, but also to ensure that ecosystems remain functional as natural infrastructure – storing carbon, buffering disasters, and sustaining livelihoods. Adaptation here means designing governance systems capable of maintaining this balance under a changing climate.

The starting point is a recognition that ecosystem resilience and community resilience are inseparable. The NAP reframes conservation from a purely ecological agenda into a socio-ecological partnership. Local communities, Indigenous and traditional societies, and women's cooperatives are not passive beneficiaries but active custodians of ecosystem services. Restoration programmes in mangroves, peatlands, and watershed forests are therefore integrated with livelihood diversification - eco-tourism, non-timber forest products, and sustainable aquaculture - that secure income while maintaining ecological integrity (Government of Indonesia, 2024a). At the national scale, adaptation priorities follow three ecological corridors: terrestrial, coastal, and marine.

- In terrestrial ecosystems, forest and peat restoration continue to anchor climate resilience. Fire prevention through rewetting, controlled burning bans, and eco-hydrological management aims to reduce transboundary haze events.
- In coastal zones, mangrove rehabilitation, shoreline protection, and integrated coastal management maintain the productivity of estuaries and safeguard fish-spawning grounds.
- In marine environments, coral restoration and sustainable fisheries management stabilize ecosystem functions that underpin local food and tourism economies (KKP, 2025).

These actions form a connected ecological network rather than isolated interventions, reflecting the 'ridge to reef' (*hulu ke hilir*) concept embedded in national environmental policy.

A critical enabler of ecosystem adaptation is data and monitoring. The National Registry System for Climate Change Control (SRN-PPI) managed by KLH/BPLH serves as the data backbone for tracking land cover, fire hotspots, mangrove extent, and blue-carbon metrics. Integration with the *Environmental Quality Index (IKLH/BPLH)* and spatial data from BRIN allows national agencies to identify priority zones where degradation, emission, and livelihood vulnerabilities intersect. By 2030, the goal is to operationalize an *Ecosystem Resilience Index (ERI)* that aggregates biophysical, socio-economic, and governance indicators to guide resource allocation.

Institutional coherence is equally important. Following the 2024 government restructuring, KLH/BPLH now coordinates adaptation across terrestrial and marine ecosystems, while the Kemenhut manages forest and peatland adaptation under the *Forest Climate Resilience Program (FCRP)*. This division ensures clear mandates, yet requires integrated planning at the landscape level. Collaboration with local governments, BRIN, and community-based organizations ensures that restoration targets are both scientifically grounded and socially legitimate.

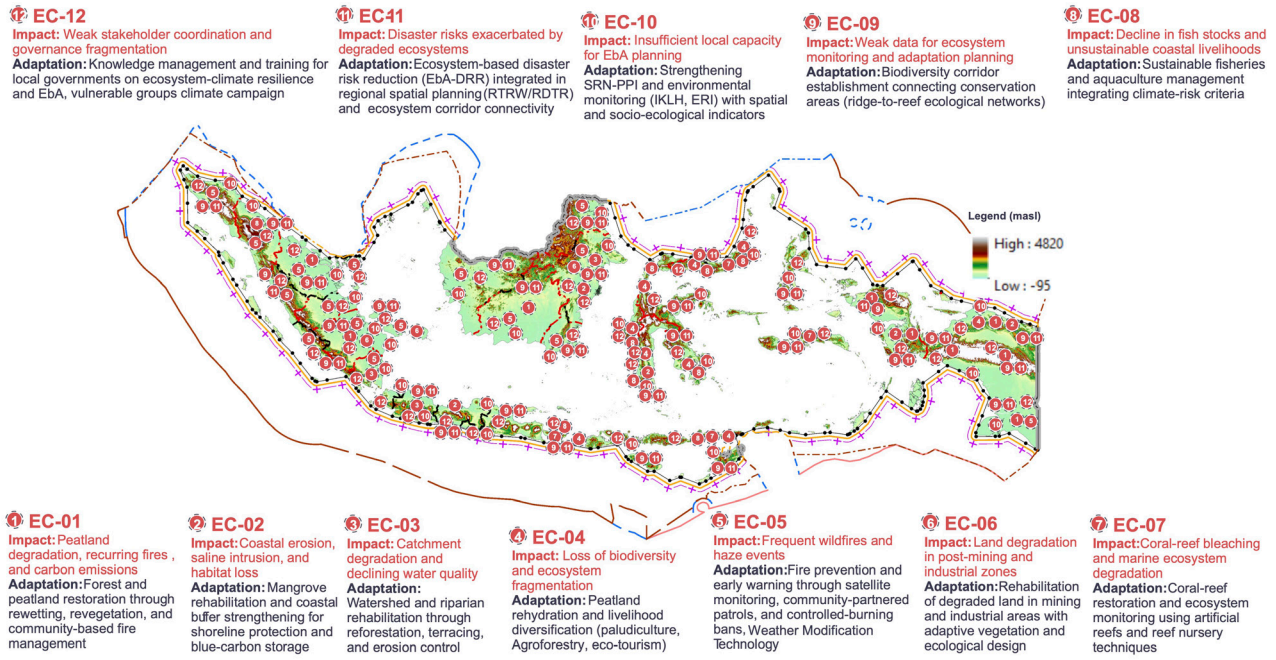


Figure 6.6 Proposed climate change adaptation action for the ecosystem sector across Indonesia considering impact and level of risk. Note: basemap constructed by administration boundary, coral reef area at a scale of 1:50,000, peat hydrological unit area, mangrove ecosystem area at a scale of 1:25,000, and river basin area by condition. Small circles on the map indicate provinces for specific actions, while large circles indicate regions. Broken red lines show indicative provincial borders, while broken black lines show definitive provincial borders. Base map source: One Map Data – BIG, 2024

Financing ecosystem adaptation involves diverse mechanisms. Public funds cover large-scale restoration and monitoring, while blended financing mobilises private-sector participation through the Environment Fund (BPDLH), blue bonds, and results-based payments from international partnerships (KLH/BPLH, 2025). These complement local community grants that reward measurable conservation outcomes under the Kampung Iklim program. Together, these mechanisms link local stewardship with national adaptation accounting.

Table 6.5 Summary of Feasible Adaptation Measures for Ecosystem Security (2026–2030 / 2035)

Code	Feasible Adaptation Measure (operational detail)	Responsible Institutions	Code	Feasible Adaptation Measure (operational detail)	Responsible Institutions
ES-01	Forest and peatland restoration through rewetting, revegetation, and community-based fire management	Kemenhut, KLH/ BPLH, Local Government, Manggala Agni	ES-07	Coral-reef restoration and ecosystem monitoring using artificial reefs and reef nursery techniques	KKP, KLH/ BPLH, Local Government, Universities
ES-02	Mangrove protection, rehabilitation, and coastal buffer strengthening for shoreline protection and blue-carbon storage	KLH/BPLH, KKP, Kemenhut, Local Government, CSOs	ES-08	Sustainable fisheries and aquaculture management integrating climate-risk criteria	KKP, KLH/ BPLH, Local Gov'ernments, Private Sector
ES-03	Watershed and riparian rehabilitation through reforestation, terracing, and erosion control	KLH/BPLH, Kemen PU, Kemenhut, Local Governments	ES-09	Biodiversity corridor establishment connecting conservation areas (*ridge-to-reef* ecological networks)	KLH/BPLH, Kemenhut, BRIN, Local Governments, KKP
ES-04	Peatland rewetting and livelihood diversification (paludiculture, agroforestry, eco-tourism)	Kemenhut, KLH/BPLH, BRIN, Local Communities	ES-10	Strengthening SRN-PPI and environmental monitoring (IKLH/BPLH, ERI) with spatial and socio-ecological indicators	KLH/BPLH, BRIN, Kemen PPN/Bappenas
ES-05	Fire prevention and early warning through satellite monitoring, community-partnered patrols, and controlled-burning bans, weather modification technology	KLH/BPLH, Kemenhut, BMKG, BNPB, private sector	ES-11	Ecosystem-based disaster risk reduction (EbA-DRR) integrated in regional spatial planning (RTRW/RDTR) and ecosystem corridor connectivity	KLH/BPLH, Kemen PPN/ Bappenas, Local Governments
ES-06	Rehabilitation of degraded land in mining and industrial areas with adaptive vegetation and ecological design	KLH/BPLH, Kemenhut, ESDM, Private Sector	ES-12	Knowledge management and training for local governments on ecosystem-climate resilience and EbA , vulnerable groups climate campaign	KLH/BPLH, Kemen PPN/ Bappenas, BRIN, Universities, NGOs

Disaster risk reduction remains a built-in outcome of healthy ecosystems. Reforestation in upper catchments reduces landslides and sedimentation; mangrove rehabilitation buffers coastal inundation; and coral reef protection mitigates storm surges. Unlike grey infrastructure, these ecosystem-based measures regenerate over time, offering both adaptation and mitigation co-benefits. The NAP therefore promotes Ecosystem-based Adaptation (EbA) as a mainstream approach in planning documents at all administrative levels

– from spatial plans (RTRW/RDTR) to environmental permits and climate-budget tagging. By 2035, the vision for Indonesia's ecosystems is both restorative and anticipatory. The short-term agenda (2026–2030) prioritises mapping and rehabilitating 1.5 million hectares (ha) of degraded lands and 600,000 ha of mangroves, alongside the institutionalisation of community forest agreements and ecosystem restoration concessions. The longer-term horizon (2031–2035) consolidates adaptive management through ecological corridors, payment for ecosystem-services schemes, and continuous monitoring through SRN-PPI. Ultimately, adaptation in this sector is not only about protecting nature, but about protecting the nation's future capacity to adapt. When mangroves recover, they also restore fisheries; when peatlands rehydrate, they secure water supply and carbon storage; and when forests thrive, they preserve the microclimates that sustain food and health systems. These interdependencies are the heart of Indonesia's NAP – where ecosystem security is the living foundation of climate resilience.

6.3 Cross-Sectoral Adaptation Portfolio

6.3.1 Economic Resilience

Economic resilience represents the convergence point where climate adaptation transforms from a sectoral intervention into a structural property of Indonesia's development system. The country's long-term growth has always been anchored in climate-sensitive sectors – agriculture, fisheries, forestry, energy and tourism – whose productivity depends on stable weather patterns, reliable water and energy supply, and healthy ecosystems (Bappenas, 2025c; Government of Indonesia, 2024a). Rising climate variability has begun to test that foundation. Losses from floods, droughts and fires have increased recurrently since 2015, eroding fiscal space, disrupting logistics chains, and exposing informal workers to livelihood instability (BNPB, 2018b). Against this backdrop, the NAP repositions the economy not merely as a beneficiary of sectoral adaptation, but as an active arena where resilience is generated through integration of policies, investments and innovation.

The analytical process undertaken in 2025 combined macro-economic risk mapping with synthesis from the Food, Water, Energy, Health, and Ecosystem portfolios. The resulting evidence indicates that climate shocks propagate through value chains rather than remaining isolated within sectors. Drought, for instance, affects hydropower output and irrigation supply, which in turn raise energy and food prices; heat waves reduce labor productivity, triggering cascading losses across manufacturing and services. Hence, economic resilience in the NAP is defined as the capacity of productive systems, financial institutions, and governance mechanisms to anticipate, absorb, and reorganize in response to climatic stress without loss of functionality or inclusiveness.

Three interconnected transformation domains underpin this outcome. The first is adaptive production and value-chain diversification. Agricultural modernization and fisheries reform introduced under the sectoral portfolios are consolidated here as national productivity strategies that distribute climate risk across space and commodities. Crop diversification programs in East Nusa Tenggara and South Sulawesi reduce dependency on rain-fed rice, while the rehabilitation of irrigation networks and solar-powered pumping in arid zones protect both yields and rural employment. In manufacturing and trade, industrial-estate adaptation plans combine drainage improvement, energy-efficiency retrofits and early warning systems, ensuring that climate risk is internalized in business-continuity management. These initiatives extend the notion of 'productive adaptation', demonstrating that resilience can enhance competitiveness rather than constrain growth.

The second domain is resilient finance and fiscal innovation. Integration of climate-risk assessment into national and local budgeting has advanced through the *Climate Budget Tagging (CBT)* mechanism, which now covers more than 20 ministries and over 100 local governments. This system enables adaptation expenditure to be tracked and evaluated for effectiveness. Parallel to fiscal measures, financial-sector adaptation has accelerated under the *OJK Green Taxonomy 2.0* and *Sustainable Finance Roadmap III*, guiding banks and insurers to incorporate climate stress testing and disclosure in their portfolios. Micro-insurance pilots initiated under the food security portfolio are being scaled into bundled risk-transfer instruments for fisheries, livestock, and MSMEs. Together, these instruments align public and private incentives toward resilience dividends rather than short-term recovery spending.

A third domain concerns enabling policy coherence and innovation ecosystems. Research institutions under BRIN, universities and regional innovation centres now act as the connective tissue between science and enterprise. Joint programmes on climate-resilient seeds, precision irrigation, renewable energy micro-grids, and circular waste management provide technological spillovers that strengthen economic productivity. At the policy level, adaptation targets are embedded in RPJMN 2025–2029 and RPJPN 2025–2045, ensuring that long-term development trajectories explicitly integrate climate resilience (Bappenas, 2025c, 2025b).

Economic resilience also depends on social inclusion and spatial equity. Adaptation finance and technology must reach micro- and small-scale producers who constitute over 90 per cent of the national workforce. Through the Program Kredit Usaha Rakyat Hijau and village-level revolving funds, adaptation capital is extended to women's cooperatives, youth enterprises and Indigenous community businesses. These local actors sustain diversified livelihoods – agroforestry, ecotourism, sustainable aquaculture – that simultaneously regenerate ecosystems and provide employment. Such measures link economic growth with ecosystem restoration outcomes.

Cross-sectoral coherence is further reinforced by infrastructure reliability. Investments in water-supply resilience (WS-01–WS-12) and energy stability (EN-01–EN-12) provide the physical backbone for productivity and trade. Ecosystem restoration (ES-01–ES-12) lowers disaster losses and maintains environmental services essential for agriculture and manufacturing. These synergies transform what were once cost centres into adaptive assets. Quantitatively, modelling by Bappenas (2025c) estimates that every IDR 1 trillion of investment in climate-resilient infrastructure yields between IDR 2–3 trillion in avoided damages and productivity gains by 2035.

Table 6.7 Economic Resilience Portfolio (2026 – 2030 Towards 2035)

CRC Code	Cascading / Compounding Risks Addressed	Cross-sectoral Adaptation Action	Focus Area	Timeline	
FS-01, WR-01	Drought reduces crop yields & irrigation capacity	Climate-smart agriculture + resilient irrigation (AWD, drought-tolerant seeds, *embung*, MAR), early warning	NTT, NTB, Sulawesi drylands, Java uplands	2026–2030	
FS-02, WR-04	Floods damaging crops, irrigation & markets	Flood-resilient agriculture & irrigation (flood-tolerant varieties, drainage rehab)	Java basins, Sumatra, Kalimantan	2026–2030	
FS-03, WR-12	Pest & disease outbreaks under humidity & warming	Integrated pest management & humidity-controlled storage (solar dryers, silos), Integrate One Health adaptation to monitor zoonotic and vector-borne diseases	Sumatra, Java, Kalimantan	2026–2030	
FS-07, EN-06	Windstorms damaging crops, livestock & grids	Windstorm-resilient agriculture & energy (windbreaks, cyclone shelters, grid hardening)	NTT, Maluku, Sulawesi, coastal Sumatra	2026–2035	
FS-08, WR-05	Salinity intrusion lowering rice & aquaculture productivity	Coastal farming protection (salt-tolerant varieties, tidal gates, mangrove buffers)	North Java, Bali, East Sumatra, Kalimantan	2026–2030	
WR-03, EN-02	Drought reducing hydropower & energy supply	Diversified renewables & decentralized systems (hybrid hydro-PV, micro-grids)	Sulawesi, Maluku, Papua	2026–2035	
EN-03, EN-07	Sea-level rise & storm surge impacting coastal energy	Coastal energy-facility protection (seawalls, elevation, relocation)	North Java, Riau, East Kalimantan	2026–2035	
EN-05, DRR-05	Extreme heat raising energy demand & logistics risk	Energy-demand management and resilient supply chains (DSM, cooling efficiency, safe warehouses)	Java & Sumatra cities and corridors	2026–2030	
EN-08	Humidity corrosion damaging energy assets	Humidity-proof infrastructure (sealed switchgear, coatings, ventilation upgrades)	Coastal tropics, humid Papua	2026–2032	
DRR-01, WR-06	Floods & landslides disrupting economic hubs	Multi-hazard EWS and resilient economic hub planning (climate-proof markets, relocation)	Java basins, Kalimantan towns	2026–2030	

Implementation follows the national investment-sequencing logic. The 2026–2030 phase focuses on aligning fiscal instruments and risk-management systems; the 2031–2035 extension embeds adaptation metrics into corporate reporting and local government budgeting. Monitoring of progress will use indicators consistent with the MRV Adaptasi framework, including the share of adaptation-tagged expenditure, insured productive assets, and proportion of MSMEs adopting risk-reduction practices.

	CSA / CRM+ Indicator	Responsible Agencies & Partners	Beneficiaries	Financing Sources	Expected Outcomes	Data Source (MRV / SRN-PPI)
	Water-use efficiency; yield stability	Kementan, Kemen PU, Local Government; Farmer Co-ops	Smallholders, women farmers	APBN, Adaptation Fund, Insurance Schemes	Stable food supply, reduced drought losses	BPS agriculture, SRN-PPI, SIDIK
	Flood-loss ratio reduction	Kementan; Kemen PU; BNPB	Farmers; traders	APBN; PPP irrigation funds	Reduced crop & infrastructure loss	BPS disaster stats; SRN reports
	Pest/disease incidence; post-harvest loss rate	Kementan; BRIN; Local Co-ops	Farmers; traders	APBN; GCF Resilience Program	Lower losses; safe nutrition	Kementan, FAO reports, SRN data
	Outage frequency; crop-loss rate	Kementan, PLN, BNPB, Local Government	Farmers, households, SMEs	APBN; Resilience Bonds; Private CAPEX	Continuity of supply; reduced disaster loss	PLN ops logs, BNPB reports
	Yield maintenance in saline zones	Kementan, Kemen PU, KLH/ BPLH, Local Government	Coastal farmers; fishers	APBN, GCF Blue Resilience	Sustained livelihoods; reduced salinization	Kemen PU irrigation stats; MoA yield data
	Share of RE in mix; reliability index	Kemen ESDM; PLN; Local Gov't	Rural communities; SMEs	REI Fund, GCF Energy Access	Improved energy security, inclusive access	PLN RE data, ESDM REI reports
	Downtime hours reduced	Kemen ESDM, PLN, Kemen PU	Coastal industries; households	APBN, PPP Infra Funds	Asset protection; supply continuity	PLN logs; hazard mapping
	Peak-load reduction, logistics continuity	PLN, Kemen ESDM, Kemen Perhubungan, Kemen PPN/ Bappenas	Urban Households, MSMEs	Private Efficiency Invest, APBN	Lower operational costs, market stability	PLN DSM reports, MoT corridor data
	Forced-outage rate reduction	PLN; Kemen ESDM	Utility customers	APBN, PLN CAPEX	Reliable service, lower maintenance costs	PLN reliability data
	Loss ratio reduction	BNPB, Kemen PPN/Bappenas, Kemen Perhubungan	Traders, farmers, urban poor	APBN, Resilience Bonds	Continuity of local trade; job security	BNPB disaster database

6.3.2 Social and Livelihoods Resilience

Social and livelihoods resilience lies at the heart of Indonesia's adaptation agenda. It defines how individuals, households and communities anticipate, absorb and recover from climate shocks while maintaining dignity and access to basic services. More than 60 per cent of Indonesia's workforce remains dependent on climate-sensitive sectors – agriculture, fisheries, forestry, and informal urban services – making social protection and livelihood diversification central to national resilience. Recent droughts, floods and coastal inundations have shown that when environmental systems fail, social vulnerability multiplies. Strengthening adaptive capacity at the community level is therefore both a human development imperative and a national security strategy.

The NAP framework approaches social resilience through three reinforcing pathways: (1) adaptive social protection; (2) livelihood diversification and inclusion; and (3) education, knowledge and capacity development. Together, they build a continuum from risk prevention to long-term empowerment.

1. **Adaptive social protection**: Conventional welfare programmes – cash transfers, food subsidies and disaster aid – are being transformed into climate-responsive instruments. The Ministry of Social Affairs (Kemensos) and Kemen PPN/Bappenas, in coordination with KLH/BPLH and BMKG, have begun embedding early warning triggers into social assistance delivery systems. Forecast-based financing (FbF) pilots in Central Java and East Nusa Tenggara automatically disburse temporary income support or asset replacement funds when rainfall or temperature thresholds are exceeded. These initiatives shorten response time, prevent distress migration, and reduce recovery costs (BNPB, 2018b). Scaling this mechanism nationwide by 2030 will link disaster management data with social registry systems (DTKS), ensuring that adaptive safety nets reach vulnerable groups before, not after loss occurs.
2. **Livelihood diversification and inclusion**: Livelihood security is strengthened by expanding economic options beyond climate-sensitive production. Under the NAP, community-based enterprises are promoted in agroforestry, non-timber forest products, ecotourism and circular-waste management. Women's cooperatives and youth start-ups receive targeted green enterprise support through the Kredit Usaha Rakyat Hijau programme and revolving village funds. In coastal regions, diversification combines aquaculture with mangrove-based products and ecolabelling schemes, creating dual income and conservation outcomes. In upland zones, farmer groups adopt integrated crop–livestock–tree systems that reduce erosion while stabilising cash flow. Collectively, these efforts operationalise the concept of livelihood-based adaptation – reducing exposure while enhancing agency.

3. **Social inclusion is a cross-cutting principle**: Women, youth and traditional communities often possess unique ecological knowledge, but face structural barriers to resources and decision-making. Adaptation programmes therefore embed gender-responsive budgeting and participatory planning. The Desa Tangguh Iklim and Kampung Iklim models exemplify this approach, combining environmental rehabilitation with leadership training for women and youth groups. By 2035, at least 10,000 villages are expected to implement these locally-owned adaptation plans, supported by integrated data from SRN-PPI and SIDIK.

4. **Education, knowledge and capacity development:** Sustained resilience requires continuous learning. The education sector, through Kemendikbud and BRIN, integrates climate literacy modules into curricula from primary schools to vocational programmes. Universities and training centres develop short courses on climate risk assessment, adaptation finance, and Adaptation MRV for local officials. The ProKlim Learning Hub-an online and blended-learning platform connects government, academia and communities, making adaptation knowledge accessible nationwide. These initiatives respond to the need for intergenerational resilience, ensuring that adaptation becomes a social norm, not an emergency reaction.

Interlinkages across these three pathways create systemic social resilience. Adaptive protection prevents short-term welfare collapse; diversified livelihoods reduce chronic vulnerability; and education – which should be gender-transformative, child-sensitive and disability-inclusive, from early childhood to vocational programmes, to equip youth with green skills for climate action – anchors behavioural and institutional change. Together they form a virtuous cycle – information improves planning, planning enables investment, and investment safeguards welfare. The integration of social protection data with climate risk indices (from BMKG and Bappenas) will allow near-real-time monitoring of vulnerability hotspots and policy targeting by 2030.

Spatially, the social resilience portfolio prioritises areas where climate hazards overlap with poverty and marginalisation: coastal deltas, drylands in Nusa Tenggara provinces, and peri-urban settlements subject to flooding and heat stress. These territories are also where migration pressures and livelihood losses are most visible. In such contexts, adaptation becomes a social contract: governments provide enabling infrastructure and finance; communities contribute local knowledge and stewardship; and the private sector facilitates innovation and market access.

Monitoring of social and livelihood resilience will rely on mixed indicators: reduction in climate-related income loss, number of adaptive enterprises, gender equity scores in adaptation programmes, and proportion of population covered by climate-triggered social

protection. These metrics are harmonized with Indonesia's *MRV Adaptasi* framework and aligned with SDG 1 (No Poverty), SDG 5 (Gender Equality), SDG 8 (Decent Work), and SDG 13 (Climate Action).

By 2035, Indonesia envisions a socially cohesive, adaptive society where every household

Table 6.8 Social and Livelihoods Resilience Portfolio (2026 – 2030 / 2035)

CRC code	Cascading / compounding risks addressed	Cross-sectoral adaptation action	Focus area	Timeline	
SP-01, DRR-02	Droughts and heat waves reducing labor productivity and income	Forecast-based social protection and climate-triggered cash transfer systems integrated with DTKS	NTT, NTB, Central Java, East Java	2026–2030	
SP-02, FS-06	Food and nutrition insecurity among low-income communities	Nutrition-sensitive home gardens and linkage to Posyandu networks (Desa Sehat Tangguh Iklim)	Eastern Indonesia, Papua, rural Java	2026–2030	
SP-03, ES-04	Loss of forest and ecosystem livelihood bases reducing income	Community-based livelihood diversification (agroforestry, NTFPs, eco-tourism)	Sumatra, Kalimantan, Sulawesi	2026–2035	
SP-04, EN-06	Energy and heat stress affecting urban workers and health	Heat-safety protocols, rest shelters and occupational health programs	Jakarta, Surabaya, Makassar, Medan	2026–2030	
SP-05, FS-04	Income loss from crop failure and market fluctuation	Weather-indexed micro-insurance bundled with credit and savings groups	West Java, South Sumatra, NTB	2026–2030	
SP-06, DRR-04	Recurrent floods disrupt access and safety for the drinking water supply system and landslides displacing households	Planned and paticipation based relocation and climate-proof housing (Desa Aman Iklim)	Central Java, West Sumatra, South Sulawesi	2026–2035	
SP-07, WS-05	Limited clean water access during droughts, saltwater intrusion, and flood in rural areas	Community-managed rainwater harvesting, Climate-proofing drinking-water systems via elevated storage and solar pumping, Flood-resilient design of pipelines and infrastructure, Community-based Water Safety Planning integrated with early warning for contamination risks, and micro water systems	Nusa Tenggara, Sulawesi, Maluku	2026–2030	
SP-08, ES-09	Weak community capacity to plan and monitor adaptation	Capacity-building and participatory planning through ProKlim and Desa Tangguh Iklim	All provinces (10 000 villages by 2035)	2026–2035	

has access to information, safety nets and climate-resilient livelihoods. Social resilience thus extends beyond relief – it embodies empowerment, fairness and sustainability. When livelihoods become flexible, institutions transparent, and communities confident in their adaptive choices, resilience ceases to be a goal and becomes a defining feature of Indonesia's national identity.

	CSA / CRM+ Indicator	Responsible institutions & partners	Beneficiaries	Financing sources	Expected outcomes	Data source (MRV / SRN-PPI)
	Early response lead time, coverage rate	Kemensos, Kemen PPN/Bappenas; KLH/BPLH, BMKG, BNPB	Vulnerable households, informal workers	APBN, Adaptation Fund, Social Resilience Trust Fund	Timely income support, reduced coping costs after shocks	Kemensos DTKS, BNPB impact reports, SRN-PPI
	Diet-diversity index, household nutrition score	Kementan, Kemenkes, Kemensos, Local government	Women, children, youth	APBN, GCF community resilience grant	Improved nutrition, enhanced food security	BPS nutrition survey, Posyandu records, SRN-PPI
	Income diversification index; forest cover gain	KLH/BPLH; Kemenhut, Kemen PPN/Bappenas, Local Co-ops	Forest communities; women co-ops	APBN; BPDLH; PPP Eco-Tourism Fund	Sustainable income; ecosystem restoration benefits	SRN-PPI, KLH/ BPLH land data, Kemen PPN/ Bappenas MoNEV
	Work-safety score; heat-incident rate	Kemenkes, Kemnake, Local Government, Private Sector	Outdoor laborers, urban poor	APBN, Private CSR, Occupational Health Fund	Reduced heat-related illness; productivity retained	Kemenkes health stats, BMKG temperature alerts
	Risk-transfer index; income-stability ratio	OJK, Kementan, Kemenkeu, Insurers	Smallholders, micro-entrepreneurs	APBN, Insurance Pools, Adaptation Fund	Stabilized income; financial security	OJK Green Finance reports, SRN data
	Household loss rate, infrastructure safety index	Kemen PU, BNPB, KLH/BPLH, Local Government	Displaced families; urban poor	APBN, PPP Housing, Resilience Bonds	Reduced displacement; safer settlements	BNPB recovery records, PUPR MoNEV, BIG
	Water-access index, drought resilience score	Kemen PU, KLH, Local Government CSOs	Rural households, women groups	APBN, Adaptation Fund, CSR Water Partnerships	Reliable water supply, reduced time burden on women	PUPR MoNEV, SRN water module
	Local capacity index, ProKlim certification rate	KLH/BPLH, Kemen PPN/Bappenas, Universities; CSOs	Village leaders; local CSOs	APBN, BPDLH, Training Grants	Stronger local governance, inclusive adaptation	SRN-PPI, KLH/ BPLH ProKlim database

6.3.3 Ecosystem and Landscape Resilience

Ecosystem and landscape resilience define the spatial and ecological backbone of Indonesia's adaptation strategy. The stability of ecosystems – mangrove, seagrass, coral reef, peatland, forest, and agro-ecosystem–marine complexes – determines how communities and economic systems respond to intensifying climate variability. Indonesia's archipelagic structure magnifies the interdependence of its ecosystems: droughts in upland catchments reduce river discharge and hydropower output, accelerating saline intrusion in coastal deltas, while deforestation and peat drainage heighten both flood and fire risks. The NAP thus treats the landscape, rather than administrative boundaries, as the functional unit for adaptation planning.

Ridge-to-Reef Integration

The first transformation domain strengthens ridge-to-reef ecosystem connectivity. Resilient watersheds secure agricultural productivity, hydropower reliability, and urban water supply; intact mangroves, seagrass and coral ecosystems buffer coastal settlements and sustain fisheries. Integrating these functions requires aligning upland and downstream management through hydrological zoning and adaptive spatial planning (RTRW/RDTR). Fifteen priority basins and deltas have been identified for coordinated interventions combining reforestation, terracing and soil-moisture retention upstream, with mangrove and seagrass rehabilitation downstream. The Ecosystem Resilience Index (ERI) – a composite indicator of hydrological stability, vegetation integrity and livelihood dependence – will guide this integration and feed into the National Registry System for Climate Change Control (SRN-PPI) for continuous monitoring. This directly addresses reviewer calls for spatially explicit, evidence-based prioritisation across sectors.

Ecosystem Restoration as Adaptive Infrastructure

The second domain reframes ecosystem restoration as adaptive infrastructure. Rather than treating conservation as a cost, the NAP positions restored ecosystems as productive assets that deliver protection and income simultaneously. Rewetting and revegetation of peatlands in Central Kalimantan and Riau reduce fire risk while maintaining water balance and enabling paludiculture; mangrove rehabilitation along the north coast of Java and in South Sulawesi stabilises shorelines and strengthens coastal food systems; forest restoration in uplands mitigates landslides and sedimentation affecting irrigation and hydropower. Economic valuation of these ecosystem services underpins investment decisions - showing that every IDR 1 trillion invested in restoration generates multiple dividends in avoided disaster loss and improved productivity. Financing instruments such as the *Environment Fund (BPDLH)*, blue bonds, and payment-for-ecosystem-services (PES) schemes link local stewardship with measurable national adaptation outcomes. This responds to reviewers' emphasis on connecting ecological results with fiscal accountability.

Adaptive Landscape Governance

TThe third domain focuses on adaptive governance across jurisdictions and institutions. The separation of the environment and forestry ministries in 2024 clarified mandates, but increased the need for coordination. Through inter-ministerial taskforces and regional landscape platforms – Forest Management Units or Kesatuan Pengelolaan Hutan (KPH) and Marine and Coastal Resilience Zones (MCRZ) – planning now integrates terrestrial, coastal and marine systems. These platforms utilise shared databases from BRIN, BMKG and local governments to synchronise land-use permits, ecosystem service mapping, and community-based monitoring. Customary institutions and local communities are engaged through participatory boundary demarcation and resource use planning, reinforcing land tenure security and compliance with restoration targets. The governance shift from project-based interventions to continuous adaptive management embodies the institutional learning central to the NAP's theory of change.

Within this adaptive governance framework, it is also important to recognise the heightened vulnerability of traditional communities whose livelihoods and cultural systems are closely tied to natural cycles and forest ecosystems. These naturalist groups – whose survival depends on the seasonal rhythms of forests, rivers and coastal resources – are often the first to experience the adverse effects of ecosystem degradation, forest fires and resource scarcity. Integrating their ecological knowledge into decision-making and strengthening their adaptive capacity through access to information, land security and sustainable livelihood programmes ensures that landscape governance remains inclusive, equitable and ecologically grounded.

Innovation and Socio-Ecological Linkages

Landscape resilience also depends on innovation that bridges ecological and social systems. Remote-sensing drones, hydrological sensors, and citizen-science applications enable communities to monitor forest cover, water quality, and fire risk in near-real time. BRIN's partnership with universities and private firms expands data utilization for early warning and resource allocation. At the same time, ecosystem-based enterprises—mangrove honey, bamboo crafts, seaweed products, eco-tourism—translate restoration efforts into tangible livelihood gains, ensuring that conservation remains economically viable. These initiatives integrate technology with local knowledge, creating feedback loops where communities are both data providers and beneficiaries of adaptive decisions.

Cross-Sectoral Implications

Ecosystem and landscape resilience amplify adaptation outcomes across sectors. Food and water security benefit from stabilized catchments and reduced sediment loads; energy reliability increases with consistent hydrological flows; health risks decline as water quality and microclimates improve. Quantitative analysis indicates that integrated ecosystem management could cut national disaster-related losses by up to 15 percent and create more

than 200 000 green jobs by 2035. Such results demonstrate that resilience is not achieved through isolated projects but through systems that connect ecology, economy, and equity.

Implementation Outlook

During 2026–2030, Indonesia will restore 1.5 million ha of degraded land and 600,000 ha of mangroves, while operationalising 15 demonstration landscapes under the ridge-to-reef programme. The 2031–2035 phase emphasises scaling through PES schemes, integration

Table 6.9 Ecosystem and Landscape Resilience Portfolio (2026 – 2030 Towards 2035)

CRC Code	Cascading / Compounding Risks Addressed	Cross-Sectoral Adaptation Action	Focus Area	Timeline	
ES-01, WR-07	Floods and erosion from degraded watersheds affecting agriculture and urban areas	Ridge-to-reef integrated watershed management (reforestation, terracing, erosion control, sediment traps)	Citarum, Way Sekampung, Mahakam, Kapuas	2026–2035	
ES-02, FS-08	Salinity and coastal erosion damaging farming and aquaculture	Mangrove rehabilitation and coastal buffer strengthening for shoreline protection and livelihoods	North Coast Java, South Sulawesi, Riau coasts	2026–2030	
ES-03, DRR-03	Peatland degradation causing fires and emissions	Peatland rewetting, paludiculture, and community fire-management (*Desa Peduli Gambut*)	Central Kalimantan, Riau, South Sumatra	2026–2035	
ES-04, EN-02	Drought reducing hydropower and irrigation flows	Integrated catchment rehabilitation and flow-regulation structures (embung, micro reservoirs)	Sulawesi, Bali, Papua rivers	2026–2030	
ES-05, FS-11	Land degradation and sedimentation reducing soil fertility and infrastructure life	Ecosystem restoration corridors and slope stabilization in critical uplands	Java uplands, Sumatra fringes	2026–2035	
ES-06, WR-10	Pollution and biodiversity loss in river and coastal ecosystems	Integrated waste-water, pollution-control systems in priority catchments and estuaries	Ciliwung, Brantas, Mahakam estuaries	2026–2030	
ES-07, ES-04	Fragmented ecosystems reducing species migration and services	Establishment of biodiversity corridors and protected-area linkages (*ridge-to-reef* model)	Papua, Sulawesi, Nusa Tenggara	2026–2035	
ES-08, DRR-02	Floods and tidal surges affecting urban and coastal hubs	Hybrid green–grey defenses (mangroves + seawalls) and resilient urban planning	Jakarta Bay, Semarang, Pekalongan	2026–2035	
ES-09, ES-10	Weak data and coordination for ecosystem planning	Development of Ecosystem Resilience Index (ERI) and integration into SRN-PPI	National; 15 priority landscapes	2026–2030	

of ERI into national planning, and mainstreaming of ecosystem indicators into regional MRV Adaptasi. Progress will be measured using the ERI, IKLH/BPLH and disaster loss indices, consistent with Chapter 7's national monitoring framework. By 2035, Indonesia aims to establish a network of adaptive landscapes that buffer hazards, sustain livelihoods, and anchor a resilient development pathway. Ecosystem and landscape resilience therefore represent both the physical and institutional manifestation of Indonesia's adaptation vision – where ecological integrity secures economic stability and social cohesion.

	CSA / CRM+ Indicator	Responsible Institutions & Partners	Beneficiaries	Financing Sources	Expected Outcomes	Data Source (MRV / SRN-PPI)
	Sediment load ↓, flood loss ratio ↓	KLH/BPLH, Kemen PU, Kemenhut, Local Governments	Farmers, urban populations	APBN, Adaptation Fund, PPP Watershed Management	Reduced flood damage, increased water reliability	PUPR MoNEV, SRN watershed module
	Blue-carbon storage, coastal erosion ↓	KLH/BPLH, KKP, Local Government CSOs	Coastal farmers, fishers, SMEs	APBN, BPDLH, GCF Blue Resilience	Shoreline stability, enhanced income security	SRN coastal registry, KKP MoNEV
	Fire incidence ↓, water-table stability↑	Kemenhut, KLH/BPLH, BRIN, Local Governments	Peatland farmers, fire-prone communities	APBN, BPDLH, REDD+ Payments	Fire risk ↓, livelihood diversification	SRN-PPI peat module, BNPB fire data
	Flow reliability index,energy-yield stability	Kemen PU, Kemen ESDM, KLH/BPLH; Local Governments	Hydropower users; farmers	APBN; REI Fund; PPP Water-Energy Projects	Sustained supply for food & energy systems	PLN REI, PUPR MoNEV data
	Vegetation cover↑, landslide risk ↓	Kemenhut, KLH/BPLH, Kemen PPN/ Bappenas, Local Governments	Farmers; local communities	APBN, BPDLH, Private CSR Reforestation	Productive soil; reduced hazard loss	SRN forest monitoring, IKLH/BPLH
	Water-quality index↑; fish stock recovery	KLH/BPLH, Kemen PU, KKP, Local Governments	Urban residents; fishers	APBN; PPP Urban Infra; Private CSR	Cleaner rivers; healthier ecosystems	KLH/BPLH water quality data, SRN monitoring
	Species connectivity index↑	KLH/BPLH, Kemenhut, BRIN, Local Governments	Conservation communities, tourism sector	APBN, BPDLH, GCF Biodiversity Fund	Species recovery, eco-tourism growth	BRIN biodiversity survey, SRN data
	Inundation frequency ↓, asset value protected	Kemen PU, KLH/BPLH, BNPB, Local Governments	Urban households; coastal industries	APBN, PPP Coastal Infra; GCF Urban Resilience	Reduced flood loss; enhanced safety	PUPR coastal MoNEV, BNPB loss data, BIG
	Data availability; spatial integration rate	KLH/BPLH; Kemen PPN/ Bappenas; BRIN	Policy-makers, research institutes	APBN, Technical Assistance, Donor Support	Evidence-based planning; adaptive policy	SRN-PPI; BRIN geo-portal

6.4 Synthesis and Transition to Operational MRV

The synthesis of Indonesia's adaptation priorities demonstrates that the country's resilience is not defined by isolated interventions, but by the integration of actions across ecological, economic and social systems. The preceding analyses confirm that climate impacts manifest through cascading and compounding risks – where a single climatic shock propagates through interconnected sectors and territories (Bappenas, 2025c). Droughts alter energy supply and food output; floods disrupt logistics and market prices; ecosystem degradation amplifies disaster frequency. The NAP therefore positions adaptation not as a defensive reaction but as a continuous transformation of governance, investment and community systems towards low-risk and equitable development.

Integrated resilience architecture

The three portfolios described in Section 6.3 – economic, social and livelihood, and ecosystem and landscape resilience – form an integrated architecture of adaptation. Together they operationalise the NAP's theory of change: strengthening the economic base through risk-responsive finance and production, empowering communities and households through social protection and adaptive livelihoods, and securing ecosystem functions that stabilise the biophysical environment. Their interdependence is circular, not hierarchical. Economic growth generates fiscal space for restoration; healthy ecosystems reduce welfare costs from disasters; inclusive governance ensures that adaptation benefits are equitably distributed (KLH/BPLH, 2025). This triad of resilience pillars constitutes the operational foundation for the 2026–2030 phase and the pathway towards a climate-secure Indonesia by 2035.

Cross-sectoral coherence and nexus approach

A critical outcome of this synthesis is the emergence of nexus strategies linking food–water–energy–health–ecosystems systems (FWEHE). The food–water–energy (FWE) nexus ensures that water allocation and energy reliability reinforce agricultural productivity; the food–water–health nexus integrates nutrition, sanitation and water safety in community adaptation; while the energy–ecosystem nexus connects renewable energy expansion with watershed and coastal integrity. These linkages transform fragmented adaptation into systemic resilience. For example, hybrid hydro–PV systems in Sulawesi improve energy access while maintaining ecological flow for irrigation; mangrove aquaculture systems restore carbon sinks while securing livelihoods; and circular economy programmes in urban corridors reduce waste, emissions and disease risk simultaneously (ESDM, 2025; KKP, 2025). Such synergies embody the reviewers' call for stronger cross-sectoral logic and avoidance of duplication between sectoral plans.

Spatial and Temporal Integration

Spatially, the NAP promotes landscape-scale implementation where adaptation is measured by ecological functionality rather than administrative jurisdiction. Fifteen ridge-to-reef demonstration landscapes – linking upper catchments, river basins and coastal deltas – illustrate how ecosystem restoration, infrastructure resilience and livelihood adaptation converge. Temporally, the plan aligns short-term actions (2026–2030) with medium-term consolidation (2031–2035) and long-term climate scenarios (2021–2050). This rolling planning mechanism ensures that near-term operational targets remain consistent with mid-century climate projections and the national vision for 2045 (Government of Indonesia, 2024a). The staged horizon also enables integration with successive RPJMN and RPJPN cycles, preventing discontinuity across administrations.

Operationalisation through MRV Adaptation

The transition from planning to implementation requires measurable progress. Chapter 7 of the NAP will establish the national *MRV Adaptasi* system as the accountability framework for adaptation. The MRV integrates three information streams:

1. Action tracking through SRN-PPI, recording all registered adaptation projects and indicators;
2. Outcome monitoring using sectoral and cross-sectoral indices – Climate-Smart Agriculture (CSA), Climate-Resilient Management (CRM+), Ecosystem Resilience Index (ERI) and Social Vulnerability Index (SVI); and
3. Impact assessment linking adaptation actions with reductions in disaster losses, poverty rates and exposure to climate hazards (Bappenas, 2025; BNPB, 2018b). Data interoperability between national and local systems – BPS statistics, DTKS social registry, PLN and Kemen PU / Kemen PR infrastructure datasets – will ensure vertical coherence from village to national scale.

Financing and Institutional Alignment

Operational success depends on sustained financing and institutional coordination. The Ministry of Finance's Climate Budget Tagging (CBT) system provides the backbone for public expenditure tracking, while blended mechanisms – Environment Fund (BPDLH), green and blue bonds, and risk-transfer instruments – extend funding to non-state actors. Adaptation finance is prioritised for regions facing the highest composite risk under SIDIK and SRN-PPI mapping. Institutional leadership is anchored by KLH/BPLH as national focal point, supported by Bappenas for planning, and line ministries for sectoral execution. Local governments function as implementers and data providers, ensuring that adaptation remains grounded in community realities.

Synthesis: Pathway to 2035

By 2035, the NAP envisions a resilient archipelago characterised by productive ecosystems, diversified economies and inclusive societies capable of withstanding climate extremes. The evidence synthesised in this chapter indicates that integrating adaptation across economic, social and ecological dimensions yields higher cumulative benefits than single-sector approaches – reducing disaster losses, sustaining livelihoods and maintaining ecosystem services simultaneously. As adaptation becomes embedded in fiscal systems, spatial planning and community practice, Indonesia transitions from vulnerability management to resilience optimisation. This synthesis thus bridges analytical results with the operational and monitoring frameworks that follow, ensuring that the NAP moves beyond a plan of intent to a system of measurable, enduring action. Each priority action identifies its corresponding investment area and financing modality, linking Section 6.3 (Action Matrix) with 7.3 (Financing Strategy).

Indonesia's NAP builds upon the national climate-risk assessment to define actionable priorities for the period 2026–2030 towards 2035. While the NAP primarily responds to current and projected climate impacts through adaptation measures, it also acknowledges that residual and irreversible loss and damage remain beyond the scope of standard adaptation efforts. These include persistent or permanent effects on ecosystems, livelihoods, infrastructure and non-economic values such as health and cultural heritage – areas where recovery may be partial or unattainable. Addressing these dimensions requires additional effort, technical capacity and financial resources that extend beyond adaptation programming. In this context, Indonesia underscores the importance of strengthening collaboration under global mechanisms such as the Funding for Response to Loss and Damage (FRLD) to complement national adaptation financing. This holistic framing ensures that adaptation actions presented in this chapter – across the five security domains (food, water, energy, health, and ecosystem and environment) and the three resilience pillars (economic, social and livelihood, and ecosystem and landscape) – collectively contribute not only to managing existing risks, but also to reducing future and residual climate-related losses.

Waste Bank in South Tangerang, Community Climate Programme © Nurul F, MoE/EPA, 2025

Volcanic Lake, Rinjani Volcano © Ika R Suratno, GIZ, 2014

A smile from Southeast Sulawesi © UNDP Indonesia, 2025

7

OPERATIONALISATION OF THE NATIONAL ADAPTATION PLAN

7.1 Purpose, Scope, and Operating Principles

The operationalisation of Indonesia's National Adaptation Plan (NAP) converts the country's adaptation priorities into implementable programmes and measurable outcomes. Its purpose is not merely administrative execution but the creation of an adaptive, learning system capable of integrating scientific evidence, governance reforms, and financial instruments into routine national and sub-national planning. This section clarifies how the Government of Indonesia will move from planning to implementation in a manner that is nationally led, fiscally coherent, and compatible with global adaptation frameworks.

Purpose

Indonesia's adaptation agenda stems from national legal obligations – Law No. 32/2009 & Law No. 16/2016 and Presidential Regulation No. 110/2025 and from Article 7 of the Paris Agreement, which calls for strengthened adaptive capacity, resilience and climate-resilient development. Complementing these instruments, MoEF Regulation No. 12/2024 provides the implementing framework that operationalises adaptation and mitigation actions and formalises coordination among the Ministry of Environment and Forestry (KLHK), the Ministry of National Development Planning (Kemen PPN/Bappenas) and the Ministry of Finance (Kemenkeu) for sectoral and cross-sectoral execution. The UNFCCC Least Developed Countries Expert Group (LEG) guidelines define the NAP as a 'continuous, progressive, and iterative process' that links assessment, planning, implementation and review. The 2025 update emphasises that NAPs should now enter their implementation and investment phase and demonstrate measurable progress by 2030.

In that spirit, Indonesia's NAP adopts a two-tier operational horizon: a first implementation tranche for 2026–2030, followed by a pathway phase extending to 2035. The first tranche focuses on executing priority measures across five critical sectors – food, water, energy, health, ecosystem – while strengthening enabling systems for data, disaster risk management and

finance. The 2031–2035 phase scales successful models, mainstreams new technologies, and aligns outcomes with the country's long-term development vision (RPJPN 2025–2045).

Scope

The operational framework covers national coordination, sectoral implementation and sub-national delivery. It is embedded in Indonesia's existing planning architecture – the *RPJMN–RKP–Renstra/Renja* sequence at the national level and the *RPJMD–RKPD* sequence at the provincial and regency/municipal levels – so that adaptation is financed and monitored through standard government systems rather than parallel mechanisms. The framework therefore transforms adaptation from a project-based agenda into a comprehensive and structured government, linking line ministry budgets, public-private partnerships and local initiatives under a single adaptive policy cycle. Operationalisation also adopts a resilience cluster logic that aligns with international adaptation economics (World Bank, 2021). Actions are organised under three reinforcing pillars:

1. **Economic resilience,** encompassing food, water, and energy systems;
2. **Social and livelihood resilience**, represented by health, community preparedness, and social protection measures; and
3. **Ecosystem resilience**, including forests, wetlands, and coastal systems that sustain biodiversity and reduce climate risks.

Each pillar is supported by cross-cutting enablers – finance, data, technology and capacity – that ensure coherence among ministries and regions. The NAP framework is aligned with the RPJMN priority pillars of infrastructure, technology, capacity building, governance and financing to ensure consistency with national development targets. The arrangement reflects the 2025 LEG guidance that effective NAPs 'institutionalise adaptation within national development frameworks' and that implementation should 'strengthen coordination across sectors, scales, and funding channels'.

Operating Principles

Operationalisation follows six principles that make adaptation both functional and sustainable:

1. **National ownership and leadership**: Adaptation is directed by the national government and implemented through line ministries and regional authorities. This approach align the UNFCCC criterion of country ownership while allowing for bottom-up innovation through community-level initiatives.
2. **Integration into development planning and budgeting**: KemenPPN/Bappenas and Kemenkeu embed adaptation actions into annual and medium-term plans using *Climate Budget Tagging* (Mutiara et al., 2021) and the the Indonesia Low-Carbon

Development Planning and Monitoring Application (AKSARA) coding system to track adaptation expenditure. Integration prevents duplication and positions adaptation as an investment that yields economic and social co-benefits.

3. **Inclusivity and participatory engagement:** Effective implementation relies on the active involvement of women, youth and vulnerable communities. Gender-responsive and socially inclusive approaches, as highlighted by UN Women (2016), enhance policy legitimacy and ensure that adaptation benefits reach those most exposed to climate risks. National guidance from the Ministry of Women's Empowerment and Child Protection (KPPPA, 2023) reinforces this principle by institutionalising gender- and youth-responsive approaches within adaptation planning, implementation and monitoring.
4. **Risk-informed and evidence-based decision-making:** Consistent with UNDRR (2020), all sectoral plans use multi-hazard data and climate scenarios from Meteorology, Climatology and Geophysics Agency (BMKG) and Geospatial Information Agency (BIG) to prioritise measures that reduce disaster and climate risks simultaneously. This convergence of disaster risk reduction and adaptation ensures more efficient use of public resources.
5. **Iterative learning and adaptive management:**The 2026–2030 tranche establishes an operational review in 2028 and a stocktake in 2030 to identify barriers and enable mid-course corrections. Lessons learned will inform the NAP Update 2031–2035, providing continuity between planning cycles and aligning with the Enhanced Transparency Framework under the UNFCCC.
6. **Transparency and accountability:** Institutional responsibilities are clearly assigned through ministerial mandates and regional decrees. Progress is discussed in inter-ministerial delivery forums and published in annual adaptation progress reports, ensuring public oversight and investor confidence.
7. **Locally led adaptation:** The NAP operational principles embrace locally-led adaptation (LLA), promoting subsidiarity, community leadership and context-specific decision-making throughout implementation phases.

7.2 Institutional and Governance Arrangements for Delivery

Effective adaptation depends on how institutions interact to convert national priorities into local action. Indonesia's institutional architecture for climate adaptation is designed to turn what was once a fragmented policy domain into a coordinated delivery system linking national leadership, sectoral execution, and sub-national participation. The arrangement demonstrates the country's shift from project-based management toward integrated governance capable of steering complex, cross-sectoral adaptation actions.

7.2.1 National Coordination and Leadership

The Ministry of Environment (KLH/BPLH) through its Directorate General of Climate Change and Carbon Governance (DJPPI), which serves as the National Focal Point to the UNFCCC and leads the National Coordination Team on Climate Change Control established under Presidential Regulation No. 110/2025. Following the issuance of the updated Perpres 110/2025, this NAP remains aligned with the revised national climate governance framework, which strengthens institutional roles and mandates across sectors, including the coordination role of regional secretariats (Setda) – particularly their natural resources divisions – as leads at the sub-national level. The Ministry of Home Affairs (Kemendagri) ensures vertical supervision and guidance for regional governments in planning, budgeting and institutionalising adaptation actions within this updated framework.

Integrated Team for Climate Change Adaptation together Kemen PPN/Bappenas, Kemenkeu, and relevant line ministries to harmonise policy, planning and finance. Cross-sector coordination is institutionalised through the National Coordination Team on Climate Change Control, ensuring alignment among ministries, sub-national governments and thematic committees on gender, health and finance. Kemen PPN/Bappenas ensures that adaptation priorities enter the National Medium-Term Development Plan (RPJMN 2025–2029) and its annual derivatives (RKP), while the Kemenkeu aligns fiscal policy through Climate Budget Tagging (CBT) and oversight of international climate finance flows. KLH/BPLH, through DJPPI TKPNEK, coordinates overall implementation and transparency, supported by the National Registry System for Climate Change (SRN-PPI) – the national registry that consolidates verified data on adaptation actions and resources. The Ministry of Women Empowerment and Child Protection (KPPPA) also participates in the coordination team to ensure integration of gender equality and child protection across adaptation policies and monitoring frameworks. This tri-institutional leadership – policy integration (Kemen PPN/Bappenas), fiscal coherence (Kemenkeu), and environmental stewardship (KLH/BPLH) – forms the central engine of Indonesia's adaptation governance, corresponding to the organisational and financial pillars identified by the World Bank (2021) as prerequisites for climate policy effectiveness.

Kick off NAP ©Clarity, GIZ

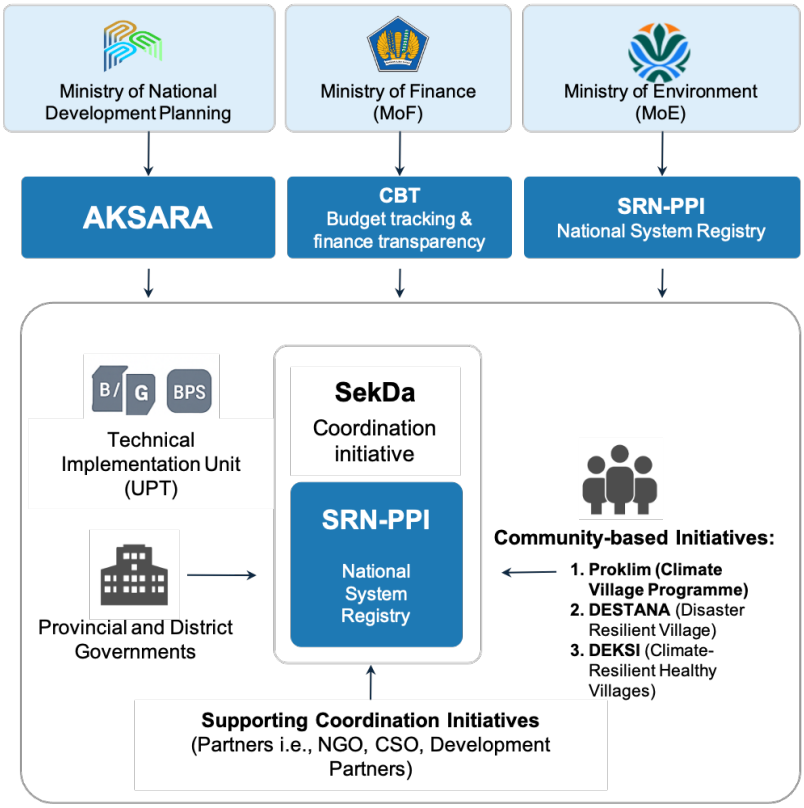


Figure 7.1. System of coordination and governance for NAP implementation

7.2.2 Sectoral Delivery Mechanisms

Operational delivery occurs through five sectoral systems that correspond to the country's resilience clusters.

a. **Food security:** The Ministry of Agriculture (Kementan) leads climate-smart agriculture, irrigation modernisation and resilient seed systems, while the Ministry of Marine Affairs and Fisheries (KKP) ensures coastal and aquaculture food security. Both coordinate with the National Food Agency (Bapanas) and the Ministry of Social Affairs (Kemensos) to integrate food security and social protection objectives – demonstrating the economic resilience pillar in action. This includes agricultural pest management programmes and climate-related early warning systems led by the Kementan to reduce climate-induced risks to crop productivity. The Coordinating Ministry for Food Affairs (Kemenko Pangan) ensures multi-sector coherence within the food security cluster, linking agricultural, marine and trade-related adaptation programmes.
b. **Water security:** The Ministry of Public Works (Kemen PU) manages national irrigation networks, flood control infrastructure, raw water, and urban drainage. Integration of hydrological data from BMKG and spatial information from BIG enables anticipatory management consistent with UNDRR (2020) recommendations for risk-informed development.

c. **Energy security:** The Ministry of Energy and Mineral Resources, supported by Perusahaan Listrik Negara (PLN) and regional energy offices, advances decentralised renewable-energy systems and grid resilience, linking adaptation with low-carbon growth strategies.
d. **Health security:** The Ministry of Health coordinates surveillance of climate-sensitive diseases, heat-health action plans, and resilient health-facility design. Collaboration with BMKG on early-warning systems reflects the *UNFCCC (2025)* guidance to strengthen existing public-health systems as adaptation vehicles.
e. **Ecosystem security:** The Ministry of Environment (KLH/BPLH) manages ecosystem-based adaptation (forests, peatlands, mangroves) and collaborates with city governments on green infrastructure and pollution control, underpinning ecosystem resilience. An integrated ridge-to-reef coordination mechanism among the Ministry of Environment (KLH/BPLH), the Ministry of Marine Affairs and Fisheries (KKP), and Ministry of Forestry (Kemenhut) ensures ecosystem-based adaptation from upland to coastal and marine areas.

Each ministry operates under sectoral regulations that embed adaptation responsibilities into statutory mandates—turning policy goals into actionable duties within existing bureaucratic structures.

7.2.3 Cross-Cutting and Enabling Institutions

Adaptation requires functions that cut across sectors: risk management, data, finance, and capacity.

- **Disaster-risk management:** The National Disaster Management Agency (BNPB) aligns early-warning, preparedness, and recovery systems with climate scenarios, reducing duplication and ensuring policy coherence. BMKG supports the National Early-Warning Services (EWS) as stipulated in the RPJMN 2026–2035 and actively participates in EWS coordination cycles to enhance anticipation and climate-related risk mitigation. In support of these efforts, BNPB is developing a dashboard for monitoring National and Regional Disaster Management Plans that can be integrated with the NAP MEL system. In addition to these measures, the NAP aligns with the RIPB (Rencana Induk Penanggulangan Bencana), the national framework for disaster management, to ensure synergy between climate adaptation and disaster-risk reduction efforts. This integration strengthens coordination across sectors and governance levels, supporting both disaster preparedness and climate-resilient actions as part of a comprehensive approach to national resilience.
- **Data and information systems:** BMKG, BIG and Statistics Indonesia (BPS) provide interoperable data services. These are coordinated through SRN-PPI, which records registered adaptation actions and facilitates information exchange among ministries and sub-national governments. SRN-PPI operates as a coordination and transparency platform

that supports, but does not replace, ministerial decision-making authority. BIG and BMKG jointly provide Indonesia's spatial and climate data infrastructure supporting multi-hazard analysis, early warning systems, and NAP monitoring through SRN-PPI interoperability.

- **Planning and budget integration tools.** Two instruments reinforce institutional coherence:
  - **AKSARA**, managed by Kemen PPN/Bappenas, integrates adaptation actions into national and regional development plans and ensures vertical alignment between *RPJMN–RKP* and *RPJMD–RKPD*.
  - **Climate Budget Tagging (CBT)**, managed by the Kemenkeu, identifies adaptation expenditures within national and regional budgets (APBN and APBD, respectively), linking financial data to AKSARA planning records and SRN-PPI reporting. CBT is an integral mechanism within KRISNA, the national planning and budgeting platform, used for tracking and managing climate-related expenditures, particularly for adaptation actions. Through KRISNA, CBT allows for the systematic identification and allocation of resources for climate resilience activities at both national and sub-national levels.
  - Together, AKSARA, CBT and SRN-PPI constitute an integrated policy loop – plan → budget →register – that supports coordination, fiscal discipline and transparency across institutions (Mutiara et al., 2021; UNDP, 2019). At the sub-national level, this integration is complemented by the Local Government Information System (SIPD), which supports regional planning, budgeting, and reporting for adaptation actions.
- **Capacity and knowledge platforms:** Universities, civil society organisations, and the Community based Climate Programme/Program Kampung Iklim (ProKlim) network implement training and outreach consistent with the Action for Climate Empowerment (ACE) framework (UNESCO, 2016).
- **Meaningful participation: women, youth, and persons with disabilities.** Ensuring meaningful participation is essential to inclusive adaptation governance. This cross-cutting priority promotes active engagement of women, youth and persons with disabilities in the planning, implementation and monitoring of adaptation actions. Mechanisms include participatory consultations, leadership programmes and accessible feedback channels integrated into the NAP delivery framework, ensuring that adaptation outcomes reflect the voices and priorities of all segments of society.

7.2.4 Sub-National Implementation

Provincial and regency/municipal governments are the operational front line of adaptation. They prepare Regional Action Plans on Climate Change Adaptation (RAD-API) and embed adaptation priorities into their *RPJMD* and *RKPD* planning document. Implementation is supported by local environmental agencies (DLH) under KLH/BPLH's guidance. Local adaptation programmes are also financed through performance-based transfers, incentive grants, and where applicable, village funds that promote community-level climate resilience. These financial mechanisms, linked to Climate Budget Tagging (CBT) codes, encourage local innovation and accountability in delivering climate actions. The *Program Komunitas*

untuk Iklim further channels community participation, ensuring that adaptation becomes a household-level practice as well as a government policy. Positioned under broader institutional and community-based programmes, ProKlim serves as a platform that strengthens local governance and adaptation capacity rather than acting as a sector-specific project. Delivery compacts between national and regional authorities specify shared responsibilities, financing sources, and expected outcomes. This model aligns with findings by the *World Bank (2021)* that decentralised delivery enhances responsiveness and policy legitimacy.

Sub-national NAP – Regional Action Plan (RAD API) – development shall be facilitated through Kemendagri to ensure vertical alignment and institutional consistency. National coordination is led by KLH/BPLH in coordination with Kemenko Pangan. At sub-national level, coordination of NAP implementation is led by regional secretariats (Setda) under their natural resources divisions rather than by regional development planning agencies (Bappeda). This structure allows policy direction from the national level to be synchronised with local planning instruments while maintaining flexibility for regions to adapt to their specific climate contexts. Kemendagri's facilitative role ensures that adaptation objectives are embedded in regional development cycles and that progress is consistently reported through established planning and budgeting mechanisms. Through this arrangement, sub-national implementation becomes both coherent with national priorities and responsive to local needs.

7.2.5 Decision-Making and Review Cadence

Decision processes follow a defined rhythm that links operational coordination with national planning and budgeting cycles:

Table 7.1 Operational coordination with national planning and budgeting cycles

Frequency	Forum / mechanism	Purpose
Monthly	Sectoral portfolio clinics	Identify bottlenecks and cross-sector dependencies.
Quarterly	Integration meetings (KLH/ BPLH – Kemen PPN/Bappenas – Kemenkeu + sector leads)	Synchronise AKSARA planning data with CBT budget codes and SRN-PPI registry updates.
Annually	National Adaptation Delivery Forum	Review progress and adjust annual work plans.
2028	Mid-cycle Operational Review	Evaluate performance of 2026–2027 tranche and adjust priorities.
2030	End-of-tranche Stocktake	Prepare 2031–2035 NAP update and feed outcomes into BTR and Adaptation Communication reports.

This cadence embodies the iterative-learning approach promoted by the *UNFCCC LEG (2025 update)*, ensuring that planning, financing, and transparency remain synchronised.

7.3 Operational Planning and Annual Programming (AOP)

Operational planning converts adaptation strategies into structured programmes and allocates resources to deliver them efficiently. It connects policy formulation, budgeting, and monitoring through a unified architecture linking the RPJMN 2025–2029, ministerial RKP and regional RKPD cycles. In Indonesia's NAP system, planning operates within established government cycles and connects three complementary mechanisms: AKSARA for planning integration, Climate Budget Tagging (CBT) for budget alignment, and the *Sistem Registri Nasiona*l (SRN-PPI) for transparency and coordination. Together they constitute the procedural backbone that links strategic intent to measurable implementation.

The funding mechanism for climate change adaptation in Indonesia, as shown in Figure 7.2, is divided into two categories: domestic and international. Domestic funding sources can come from private investment and the State Revenue and Expenditure Budget (APBN). APBN funds can take the form of DAU, DAK, DBH, DTP, HH and DD through ministries, NSE, state-owned enterprises (SOEs) and the Indonesia Climate Change Trust Fund (ICCTF). International funds are obtained through development partners and partner countries, including technical assistance, grants and loans. This funding is accessed through multilateral and bilateral development banks, and multilateral and bilateral institutions. These intermediaries, through the Environment Fund (BPDLH), are processed as off-treasury, which are also included in the APBN. The Environment Fund Management Agency (BPDLH) enables domestic and international, as well as public and private funding to be pooled for distribution through various financial instruments across various sectors. BPDLH is the first public service agency to manage funds from international sources (both public and private). Ultimately, all these funds are executed by implementing agencies, including local governments, NGOs and research institutions. They are then required to submit reports back to the intermediary institutions as a form of accountability.

NAP planning by Adaptation Directorate, MoE/EPA team, © Ika R Suratno, GIZ, 2025

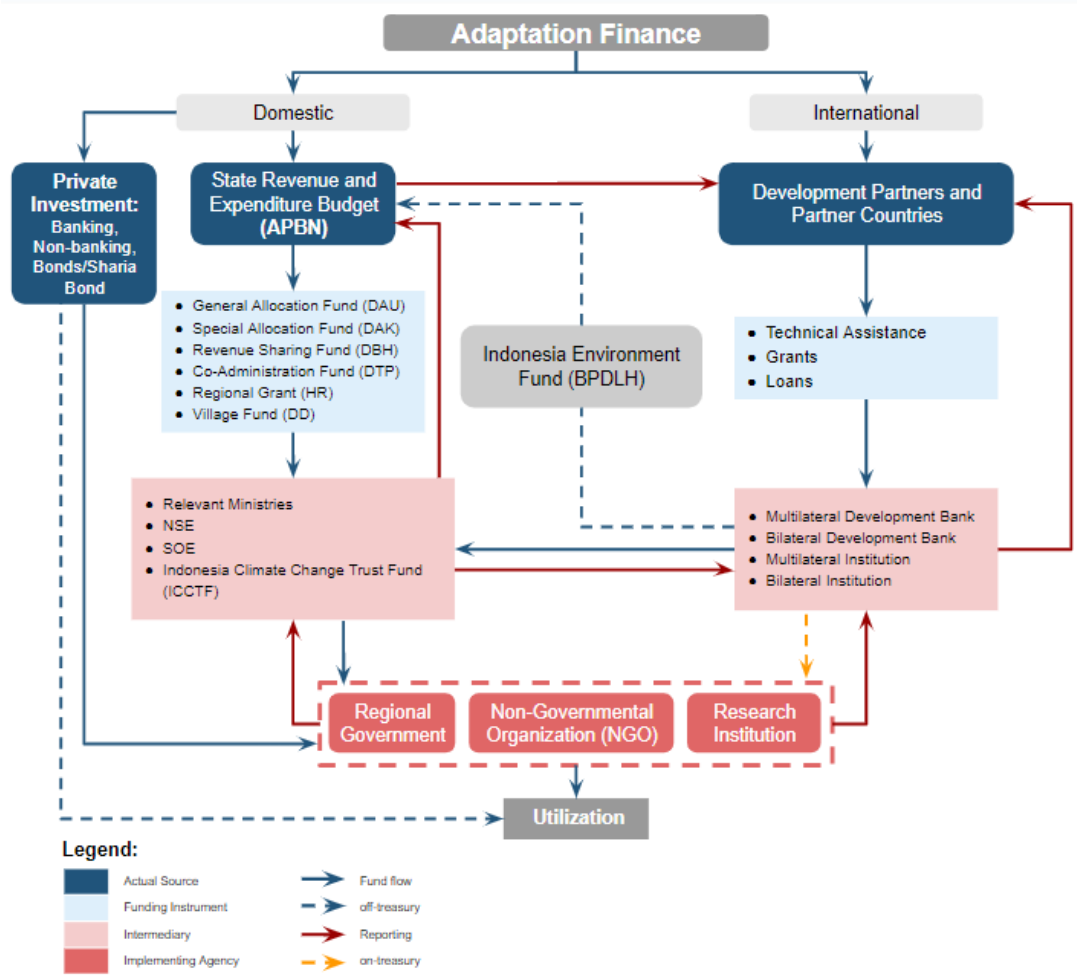


Figure 7.2 ***National financing and resource mobilization architecture for adaptation***

7.3.1 Purpose and Function

The AOP process serves two functions:

1. to translate the adaptation portfolios and feasible measures identified in Chapter 6 into multi-year and annual operational plans; and
2. to ensure that these plans are formally recognised within Indonesia's planning and budgeting architecture, thereby guaranteeing fiscal continuity.

Following the *UNFCCC LEG (2012; 2025 update)* guidance, Indonesia's planning framework is "iterative and nationally anchored," meaning that every adaptation action must enter the routine *RPJMN–RKP–Renstra/Renja* and *RPJMD–RKPD* planning cycles rather than remain a project outside the national system. Embedding adaptation into these cycles not only institutionalizes long-term resilience but also allows for annual policy calibration in response to evolving risks and fiscal space.

7.3.2 Integration through AKSARA (Kemen PPN/Bappenas)

At the strategic level, Kemen PPN/Bappenas integrates adaptation into planning through Indonesia Low-Carbon Development Planning and Monitoring Application (AKSARA) – a digital and methodological platform that consolidates sectoral and regional proposals into a single national adaptation registry for planning purposes. Each line ministry and provincial government inputs its priority adaptation actions, which are then appraised against climate risk data, socio-economic indicators, and alignment with the RPJMN 2025–2029 targets. The AKSARA process ensures three forms of coherence:

- **Vertical coherence** between national and regional plans: Provincial *RAD-API* priorities are matched with national sectoral strategies, reducing duplication.
- **Horizontal coherence** across sectors: Actions from food, water, energy, health, and ecosystem portfolios are screened for cross-benefits or overlaps.
- **Temporal coherence** with fiscal years: Outputs and milestones are synchronized with annual *RKP* and *Renja* preparation, enabling on-time budget requests.

Through AKSARA, adaptation ceases to be an external add-on; it becomes an integral element of the government's planning matrix. The approach reflects the GIZ (2023) recommendation that macroeconomic and climate models be combined to identify adaptation priorities that generate growth and resilience dividends.

7.3.3 Phasing of Implementation (2026–2035)

Operational planning follows a phased structure that aligns with Indonesia's medium-term development planning and with the *UNFCCC* expectation of demonstrating NAP progress by 2030.

Table 7.2 Phased structure for operational planning aligns with RPJMN

Phase	Period	Objective and core tasks
Phase I – Foundation and Quick Wins	2026–2027	Establish enabling systems; execute priority measures with immediate benefits (e.g. early warning services, resilient seed distribution, urban drainage upgrades); calibrate planning and budget instruments
Phase II – Consolidation and Mid-Cycle Review	2028	Conduct an operational review to assess efficiency, financing adequacy, and institutional performance; re-prioritise actions based on lessons learned and new risk data.
Phase III – Scaling and Stocktake	2029–2030	Expand successful models; complete large-scale infrastructure and ecosystem restoration projects; undertake a national stocktake to prepare the 2031–2035 update.
Phase IV – Pathway to 2035	2031–2035	Integrate updated actions into the next RPJMN (2030–2034) and scale proven measures nationwide

This phasing institutionalises iterative learning – the hallmark of adaptive planning – by embedding review points (2028 and 2030) that feed into the next NAP cycle.

7.3.4 From Plan to Budget: Linking AKSARA and CBT

Once actions are validated through AKSARA, they enter the budgeting process via Climate Budget Tagging (CBT) and Gender-Responsive Climate Budget Tagging managed by the Ministry of Finance. CBT assigns a specific code to adaptation-related expenditures in both the national (*APBN*) and sub-national (*APBD*) budgets. This ensures traceability of climate spending and allows the government to quantify adaptation investment flows. Studies show that CBT improves fiscal coherence by aligning financial inputs with policy outcomes (Mutiara et al., 2021; UNDP, 2019). The AKSARA–CBT linkage performs two essential tasks:

1. It transforms adaptation priorities into legally funded programmes, eliminating the risk that adaptation remains aspirational.
2. It enables periodic expenditure reviews to assess whether financial allocations correspond to climate-risk levels and sectoral exposure.

Fiscal coordination meetings between Kemen PPN/Bappenas and the Kemenkeu held quarterly as part of the NAP's delivery cadence - update these linkages, ensuring that adaptation remains visible in both planning and finance.

7.3.5 Sub-national Programming and Delivery Compacts

Provincial and regency/municipal governments prepare their annual programmes within the RPJMD–RKPD framework, guided by national priorities listed in AKSARA. To enhance accountability, delivery compacts – formal agreements between the national steering committee and provincial governors – specify expected outputs, financing sources and technical assistance. This instrument mirrors international best practice in performance-based adaptation governance (World Bank, 2021). Regional agencies can access earmarked funds through performance-based transfers tied to CBT codes. These incentives encourage local governments to integrate adaptation into spatial planning, water management and agricultural extension services, thereby strengthening the territorial dimension of resilience and ensuring that national adaptation priorities are effectively translated into measurable local outcomes.

7.3.6 Coordination and Information Flows

During implementation, data on progress and financing are channelled to the SRN-PPI, the national registry maintained by the KLH/BPLH. SRN-PPI records verified adaptation actions, links them to CBT budget entries, and provides information for domestic coordination and international reporting. Although primarily a transparency instrument, SRN-PPI also functions as a coordination tool, enabling ministries to avoid overlap and to share technical data. Its role here remains procedural: it supports, but does not replace, planning or budgeting authority.

7.3.7 Analytical Reflection: Rationality and Benefits of the AOP System

The operational planning system resolves three persistent challenges in adaptation governance - unclear prioritization, inconsistent financing, and weak feedback loops.

1. **Clarity of prioritisation:** AKSARA introduces a national framework for appraising and sequencing adaptation measures using objective criteria - exposure, vulnerability, and potential co-benefits - thereby depoliticizing the selection process.
2. **Fiscal consistency:** CBT embeds adaptation within mainstream budget codes, guaranteeing predictable annual funding while allowing the Kemenkeu to report aggregated climate-finance data to the *Enhanced Transparency Framework*.
3. **Feedback and learning:** By connecting AKSARA (planning), CBT (budgeting), and SRN-PPI (registry), the system provides a full information loop for adaptive management. This arrangement corresponds to the *UNFCCC LEG (2025)* guidance that NAP implementation should link planning, finance, and monitoring in a single iterative cycle.

Empirical evidence supports this design. Countries that institutionalize adaptation within their fiscal frameworks achieve higher efficiency and stronger accountability (World Bank, 2021, UNDP, 2019). In Indonesia, the tri-system alignment enhances policy predictability for investors and development partners, while enabling local governments to access resources through standardised procedures.

7.3.8 Future Improvements and Pathway to 2035

Strengthening institutional linkages between national and sub-national governments will remain a key priority to ensure vertical integration and the effective delivery of adaptation actions. Building on lessons from the first implementation phase, operational planning will evolve to enhance digital interoperability, fiscal adaptability, and systematic knowledge feedback across governance levels. These improvements will enable Indonesia's AOP system to operate more efficiently, anticipate fiscal needs under uncertain climate conditions, and continuously refine priorities in line with national development goals and socio-economic transformation. Looking ahead, operational planning will evolve in three directions:

1. **Digital integration:** AKSARA, CBT and SRN-PPI will be made interoperable to reduce reporting burdens and allow automatic data exchange.
2. **Adaptive budgeting:** Scenario-based budgeting methods, as suggested by GIZ (2023), will help ministries anticipate fiscal needs under varying climate conditions.
3. **Knowledge feedback:** Lessons from the 2028 review and 2030 stocktake will inform the next RPJMN (2030–2034), ensuring that adaptation priorities remain aligned with socio-economic transformation goals.

7.4 Technology, Infrastructure, and Innovation Deployment

Technology and infrastructure are the tangible expressions of adaptation policy. For Indonesia, they are not simply technical add-ons but engines that convert the NAP's strategic intentions into resilient livelihoods, ecosystems, and economies. Section 7.4 describes how technologies and infrastructure for adaptation are identified, deployed, and continually improved through innovation and learning. It reflects Indonesia's commitment to align present-day implementation (2026–2030) with future readiness toward 2035.

7.4.1 Strategic Role of Technology and Innovation

Projected climatic changes – hotter temperatures, prolonged droughts, more intense rainfall and rising sea levels – require both proven technologies and continuous innovation. The UNFCCC LEG (2025) emphasises that NAPs must treat technology not as a single transfer event, but as a dynamic cycle of research, deployment and diffusion. Indonesia's regulatory basis – Presidential Regulation No 110/2025 and MoEF Regulation 12/2024 – already embeds this logic, mandating integrated management of adaptation technologies.

Technological advancement serves two inter-locking purposes. First, it enables the immediate deployment of feasible measures identified in Chapter 6 through line ministry programmes and sub-national delivery. Second, it builds a national innovation ecosystem that can anticipate and respond to emerging risks beyond 2030. In practice, this means coupling national R&D capacity with local ingenuity, ensuring that adaptation solutions are continuously refreshed, affordable and context-specific.

7.4.2 Coordination and Sectoral Deployment

Technology deployment operates through established institutional mandates coordinated by KLH/BPLH and supported by Kemen PPN/Bappenas, Kemenkeu and relevant line ministries. Kemen PPN/Bappenas integrates adaptation technologies into planning via AKSARA; MoF secures fiscal alignment through Climate Budget Tagging (CBT); and KLH/BPLH records verified implementation through the National Registry System (SRN-PPI). Together these mechanisms ensure that technology deployment is planned, funded and transparently monitored within Indonesia's governance system. Deployment pathways differ by sector, yet share a common logic of risk reduction, innovation and community participation:

- **Food systems:** The Ministry of Agriculture (Kementan) promotes climate-smart farming—drought-tolerant seeds, micro-irrigation, precision fertiliser use and integrates BMKG's climate forecasts into digital farm-advisory services. Collaboration with

universities and agritech start-ups localises technologies for smallholders, increasing yield stability and water efficiency.

- **Water resources.** The Ministry of Public Works (Kemen PU) constructs small reservoirs (*embung*), rehabilitates irrigation canals, and designs "smart drainage" using hydrological data from BMKG and geospatial mapping from BIG. This operationalises *UNDRR (2020)* principles of risk-informed infrastructure, linking disaster-risk reduction with long-term adaptation.
- **Energy.** The Ministry of Energy and Mineral Resources (ESDM) installs solar-powered water pumps, decentralised mini-grids, and energy-efficient public facilities. These measures strengthen economic resilience in remote areas and complement Indonesia's clean-energy transition.
- **Health.** The Ministry of Health (Kemenkes) deploys early-warning and response systems for vector-borne and heat-related diseases and upgrades facility design—elevated structures, improved ventilation, autonomous energy supply. Partnerships with BMKG support the *Climate-Health Early-Warning System (CHEWS)*, ensuring preparedness for future heat and disease patterns.
- **Ecosystems.** The Ministry of Environment (KLH/BPLH) and Ministry of Forestry expands ecosystem-based adaptation (EbA): mangrove rehabilitation, peat re-wetting, reforestation, and urban green corridors. City governments integrate permeable pavements and retention parks into spatial plans, combining flood mitigation with urban cooling.

These pathways demonstrate that adaptation technologies are delivered through ordinary sector programmes – anchored in mandates and budgets – rather than isolated projects.

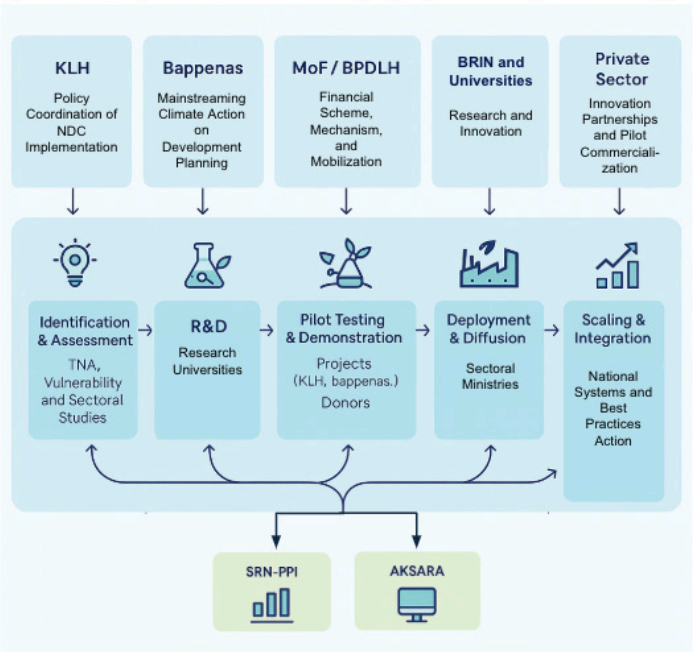


Figure 7.3 Technology and Innovation deployment pathway for adaptation

The technology and innovation deployment pathway for climate change adaptation in Indonesia is a structured process that operates through coordinated institutional mandates. This process is led by KLH/BPLH as the coordinator for NDC implementation policy, and is supported by various key stakeholders. Kemen PPN/Bappenas is responsible for mainstreaming climate action into development plans; Kemenkeu and BPDLH are tasked with designing schemes and mobilising financing; the National Research and Innovation Agency (BRIN) along with universities drive research and innovation; while the private sector is engaged as a partner in innovation piloting and commercialisation. This workflow progresses systematically, starting from the identification and assessment of sectoral vulnerabilities, followed by in-depth research, pilot tests and demonstration projects, technology application and diffusion, and ultimately reaching the stage of scaling-up and integration into national systems and best practices

To ensure this pathway operates effectively, this collaborative framework is reinforced by concrete and integrated governance instruments. Kemen PPN/Bappenas actively integrates adaptation technology priorities into development planning through the AKSARA platform. On the fiscal side, Kemenkeu ensures budget alignment and allocation through the Climate Budget Tagging (CBT) mechanism. Meanwhile, to ensure accountability, KLH/BPLH verifies and monitors all on-the-ground implementation of actions through SRN-PPI. Collectively, the synergy between these actors, the structured stages, and these governance instruments ensures that the deployment of adaptation technology can be planned, funded and monitored transparently within the national governance system..

7.4.3 Governance, Standards, and Systems Integration

Effective deployment depends on governance instruments that ensure quality, transparency and fiscal discipline. The National Standardisation Agency (BSN) and line ministries continually update standards – building codes that incorporate climate parameters, efficiency standards for agricultural and water management equipment, and monitoring protocols for ecosystem restoration. Public procurement reforms now permit 'innovation partnerships', allowing ministries to test emerging technologies under controlled risk conditions while maintaining accountability.

Institutionally, technology deployment operates within a single information and financial loop: Plan (AKSARA) → Budget (CBT) → Register (SRN-PPI) → Learn and Adjust. AKSARA integrates technologies into planning documents; CBT codes guarantee their inclusion in the budget; SRN-PPI records implementation and outcomes, feeding evidence back into planning. This closed loop exemplifies adaptive management and satisfies transparency expectations under the Enhanced Transparency Framework (Republic of Indonesia, 2024). Private sector engagement is facilitated through tax incentives and public–private

partnerships, while green procurement guidelines prioritise low-carbon, climate-resilient materials. Together, these governance and financing standards ensure that adaptation technologies deliver measurable value for public investment.

7.4.4 Innovation and Technology Needs Assessment

Continuous innovation is essential for long-term resilience. Indonesia therefore institutionalises a Technology Needs Assessment (TNA) every five years, coordinated by KLH/BPLH with Kemen PPN/Bappenas, National Research and Innovation Agency, and other relevant line ministries. The TNA will:

1. Identify future technology gaps and needs across the five priority sectors based on climate projections and socio-economic scenarios;
2. Prioritise technologies that yield high resilience dividends and co-benefits;
3. Map domestic R&D and private-sector capacities; and
4. Define enabling conditions - policy incentives, financing instruments, and intellectual-property frameworks - for diffusion.

Outputs of the TNA feed directly into AKSARA for planning and CBT for budgeting, ensuring that innovation priorities are financially embedded rather than aspirational. To strengthen collaboration, a National Innovation Platform for Climate Adaptation (NIPCA) will convene ministries, universities, start-ups, and communities under the National Adaptation Technology Forum. The platform promotes south–south cooperation, supports pilot projects, and incubates local solutions – from bio-engineering for slope stability to AI-based hydrological forecasting. It also facilitates technology transfer and capacity building through bilateral and multilateral partnerships under the Paris Agreement Article 10 framework. Gender-responsive and youth-led entrepreneurship are prioritised to mainstream inclusion (UN Women, 2016; UNESCO, 2016). Financing for innovation follows blended principles: CBT-coded R&D funds de-risk early stages, while private investors and international partners finance scaling through green bonds and climate-venture funds. This aligns with UNDP (2019) and GIZ (2023) recommendations to leverage public resources to catalyse private adaptation investment

7.4.5 Capacity, Knowledge, and Gaps to 2035

Human capital and institutional learning underpin all technological success. Universities and vocational schools, supported by KLH/BPLH and Kemen PPN/Bappenas, expand curricula on climate-resilient engineering, hydrology, health, and agriculture. Training modules for regional agencies and community networks strengthen local competence to maintain and replicate technologies. ProKlim communities serve as living laboratories for

adaptive practices, linking scientific knowledge with traditional wisdom. Despite strong progress, several operational gaps remain:

- **Data interoperability:** Automation among AKSARA, CBT, and SRN-PPI must be completed to allow real-time information sharing.
- **Technical standards:** Emerging materials and digital tools need climate-specific certification.
- **Specialised skills:** Expertise in climate modelling, engineering design, and adaptation economics remains limited outside major institutions.
- **Finance accessibility:** Local innovators require simplified access to adaptation funds and risk-sharing instruments.
- **Knowledge management:** Field lessons should be systematically captured and disseminated through SRN-PPI and NIPCA.

Recognising the role of children and youth as agents of change in adaptation is equally important, particularly through expanded climate education and peer-counselling initiatives across regions. Addressing these needs will ensure that Indonesia's adaptation technologies evolve in tandem with changing climatic realities. Sustaining these improvements, however, depends on predictable and well-aligned financing that supports the entire operational loop – planning, governance, capacity and innovation. Section 7.5 therefore elaborates the financing and resource mobilisation architecture that enables this system to function as a coherent national framework.

7.5 Financing and Resource Mobilisation

Financing the NAP is not limited to projects or sectoral programmes; it sustains the entire operational loop – policy, governance, data, technology, innovation, capacity and monitoring. Align the NAP financing framework with RPJMN 2025–2029 and RPJPN 2020–2045 to ensure long-term continuity and investment sustainability. Indonesia's adaptation finance architecture therefore aims to ensure that each rupiah invested generates measurable resilience value, leverages private and concessional capital, and guarantees access for national and sub-national actors alike

7.5.1 Strategic Objective and Principles

The objective of adaptation finance is to provide predictable, transparent and equitable resources that enable the implementation of NAP actions across all pillars - economic, social-livelihood, and ecosystem resilience. Financing under the NAP follows five guiding principles derived from *UNFCCC LEG (2025)*:

1. **Integration** – adaptation embedded in existing fiscal systems;
2. **Country ownership** – nationally driven and aligned with RPJMN 2025-2029;
3. **Effectiveness** – prioritising resilience return on public spending;
4. **Transparency** – traceable through national reporting instruments; and
5. **Inclusivity** – enabling participation of women, youth, and local communities.

Public budgets remain the foundation, yet their primary role is catalytic – de-risking investments so that larger flows from the private sector and international partners can be mobilised efficiently. Ensure that the definition and operationalisation of blended finance in Indonesia align with UNFCCC guidelines, combining concessional and commercial financing. Under this approach, concessional resources are strategically mixed with market-based finance to de-risk investment and crowd in private capital, while public–private partnerships (PPPs) remain contractual mechanisms for infrastructure delivery rather than blended finance instruments.

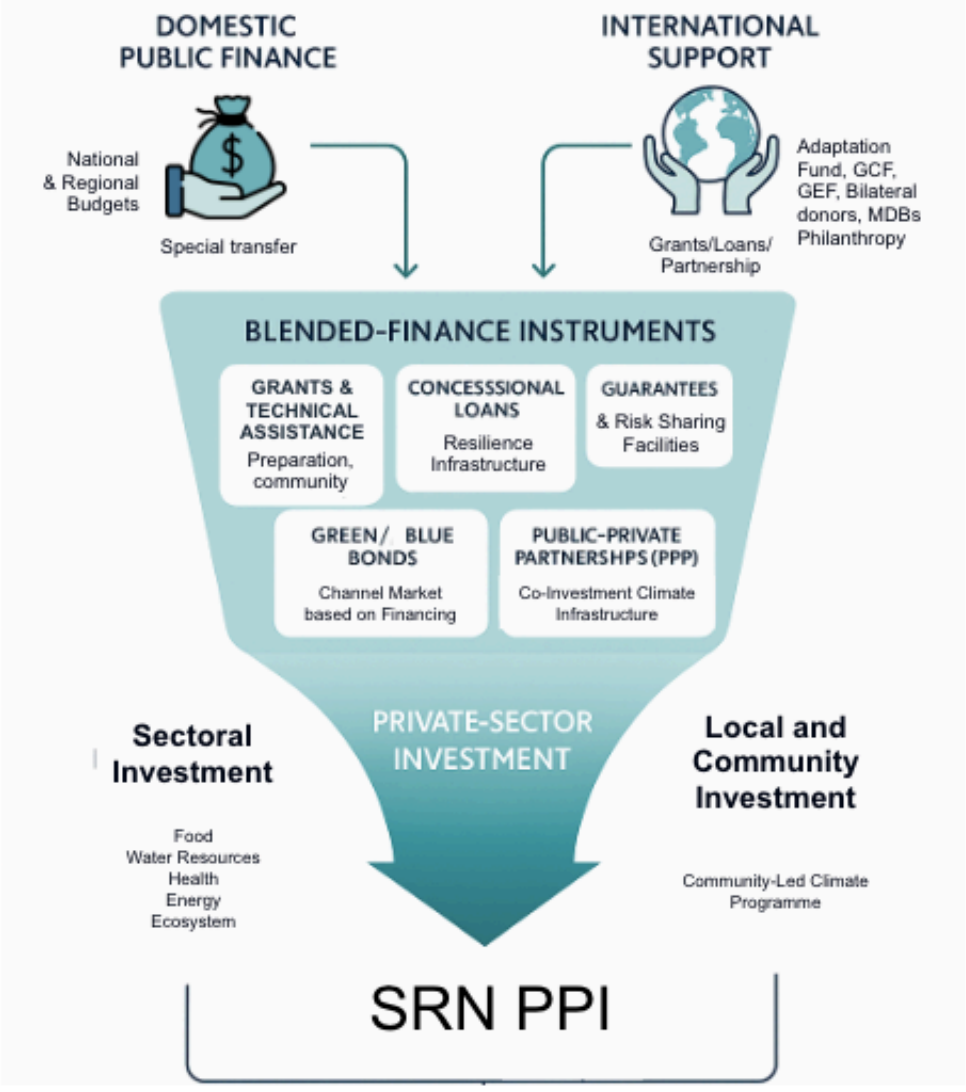


Figure 7.4 ***De-risking and leveraging mechanisms for adaptation finance***

The integration mechanism for climate change adaptation finance, as depicted in Figure 7.4, explains how Indonesia's financing framework integrates two primary funding modalities: domestic public finance from national and regional budgets, and international support from adaptation fund, GCF, GEF, bilateral donors, and MDBs philanthropy. Both funding sources are synergised through policy frameworks like Climate Budget Tagging (CBT) and the Integrated National Financing Framework (INFF), and are subsequently channelled into blended financial instruments. These include grants, technical assistance for communities, concessional loans for resilience infrastructure, green/blue bonds, risk guarantees and PPPs, all designed to de-risk and leverage in order to significantly mobilise private sector investment. Green and blue bonds are categorised under capital market instruments and may qualify as blended finance when concessional elements are embedded.

The resulting investments cover key sectors such as agriculture, water, energy, health, the environment, and coastal and urban areas, while also supporting local and community initiatives through programmes like the Proklim community climate programme. The entire process is ultimately recorded and monitored within the National Registry System for Climate Change Control (SRN-PPI) and the Adaptation Window. This serves as part of a broader effort to strengthen national adaptation governance and engage the private sector and local communities in climate adaptation action.

7.5.2 Funding and Financing Mechanisms

Adequate and predictable financial resources are essential to sustain the implementation of Indonesia's NAP. Funding and financing function as two complementary pillars within the national climate finance architecture, ensuring that adaptation priorities receive both immediate fiscal support and sustained long-term investment. While funding provides the initial capital for planning and early-stage implementation, financing instruments expand and maintain these efforts through public–private collaboration and capital-market participation, thereby enhancing resilience outcomes across governance levels.

Funding Sources and Access.

Public budgets remain the backbone of adaptation finance. The state budget (APBN) and regional budgets (APBDs) allocate climate-tagged expenditures through the Climate Budget Tagging (CBT) system managed by Kemenkeu and Kemen PPN/Bappenas, allowing traceability of adaptation spending in line with NAP targets. Regional governments channel adaptation programmes through Special Allocation Funds (Dana Alokasi Khusus – DAK), Regional Incentive Funds (Dana Insentif Daerah – DID) and Village Funds (Dana Desa), supported by performance-based transfers that reward local innovation.

The Environment Fund Management Agency (BPDLH) acts as a national intermediary pooling domestic and international contributions. It provides grants, subsidies and

technical-assistance windows while recycling performance-based payments, carbon pricing revenues, and ecosystem service compensation to strengthen community-based adaptation. Indonesia also accesses non-repayable resources through the Adaptation Fund, Global Environment Facility and Green Climate Fund, complemented by bilateral and multilateral partners such as UNDP, GIZ, JICA and the World Bank. Grant financing supports research, pilot projects, and knowledge management that feed back into national planning and budgeting cycles (CPI, 2023; AdCom, 2022; OECD, 2021; UNDP, 2019).

Financing Instruments and Disbursement.

Beyond grants, Indonesia employs a range of capital instruments to mobilize investment and distribute risk. Blended-finance facilities combine public and concessional funds to attract private participation in sectors such as sustainable agriculture, renewable energy, and urban resilience. Kemenkeu and Kemen PPN/Bappenas coordinate these facilities through the Integrated National Financing Framework (INFF), supported by interest-rate subsidies, guarantees, and performance-based payments (World Bank, 2021).

Public–Private Partnerships (PPPs) strengthen the delivery of climate-resilient infrastructure – flood control systems, water supply networks, and resilient housing – using availability payment and output-based models that link government payments to verified service performance. To mobilise capital market investment, Indonesia has issued sovereign green bonds and sukuk sharia compliant bonds since 2018, and is expanding towards blue bonds to finance coastal and marine adaptation (KKP, 2025; Kemenkeu, 2024). Financial institutions are further encouraged to provide climate risk credit lines and micro-insurance products for farmers and SMEs, while parametric insurance pilots address losses from floods and droughts (BNPB, 2025; Kementan, 2025; OJK, 2024). Finally, under Indonesia's Carbon Economic Value (NEK) policy, verified adaptation outcomes generate performance-based payments and credits for mitigation co-benefits (Permen LHK 12/2024). This approach links financial flows to measurable impact indicators within the SRN-PPI and MEL systems, reinforcing accountability and adaptive learning in national and sub-national implementation.

Community based financing, West Kalimantan ©SASCI+, GIZ, 2025

7.5.3 Institutional Architecture and Fiscal Integration

Indonesia's financing architecture operates through three interlinked instruments that anchor planning, budgeting, and transparency:

Table 7.3 Financing architecture instruments

Instrument	Lead Institution	Core Function
AKSARA	Ministry of National Development Planning (Kemen PPN/Bappenas)	Integrates adaptation priorities into development plans and investment pipelines.
CBT (Climate Budget Tagging)	Ministry of Finance (Kemenkeu)	Identifies and codes adaptation expenditure in APBN/APBD budgets and tracks fiscal performance.
SRN-PPI	Ministry of Environment (KLH/BPLH)	Registers actions and financial flows, ensuring transparency for ETF/BTR reporting.

Together they form the Plan →Budget →Register →Report continuum. This integration allows adaptation finance to cover operational functions – policy coordination, data, technology deployment, MEL, and capacity development – ensuring systemic, not programmatic, support. Fiscal oversight is reinforced by the National Coordination Team for Climate Change and Kemen PPN/Kemen PPN/Bappenas–Kemenkeu joint committees that align AKSARA plans with CBT ceilings and SRN-PPI verification cycles. The Environment Fund Management Agency (BPDLH) serves as the principal financial intermediary, pooling resources from state budgets, international grants and private contributions.

7.5.4 De-Risking and Investment Leverage Strategy

Public finance in the NAP acts as a risk-management engine. Rather than replacing private or concessional funding, it absorbs early-stage and non-commercial risks that deter investors. Three complementary de-risking modalities operate across sectors:

1. **Viability-Gap Funding (VGF)**: public funds bridge initial revenue gaps for climate-resilient infrastructure (e.g., flood-control, resilient housing).
2. **Guarantee and Insurance Instruments**: partial-credit guarantees, sovereign insurance pools, and micro-insurance reduce exposure to climate and credit risk.
3. **Blended Finance Structures**: public or concessional capital provides first-loss tranches in adaptation funds, encouraging commercial lenders to participate.

Economic modelling from national studies – adapted from the Low Carbon Development Initiative (LCDI) framework – indicates that each rupiah of public adaptation spending can leverage four to seven rupiah in total investment (public + private + concessional), depending on risk profile and sector maturity. Fiscal-policy instruments – carbon-pricing revenues, green sukuk proceeds, and results-based payment schemes – are reinvested in adaptation portfolios through BPDLH to maintain the leverage cycle and ensure the sustainability of adaptation financing

Table 7.4 Indonesia's adaptation-finance sources and functions (2026–2035)

Funding cluster	Examples of sources	Functional role in NAP finance
Public Finance	National budget (APBN), Sub-national budget (APBD), BPDLH trust funds	Baseline and de-risking capital; supports core functions and essential infrastructure.
International Concessional Finance	Green Climate Fund, Adaptation Fund, GEF, bilateral climate windows	Catalytic finance for innovation and capacity building; co-financing with CBT allocations.
Private and Blended Finance	PPPs, green and blue bonds, ESG investment funds	Scales up investment in resilient infrastructure and supply chains; mobilises market finance.
Philanthropic and Community Finance	Foundations, faith-based organisations, crowdfunding platforms	Direct support for local innovation and equity programmes (ProKlim, co-ops).

By deploying public funds strategically to absorb risk and certify impact, Indonesia enhances both efficiency (impact per rupiah) and effectiveness (sustainability of finance).

7.5.5 Funding Flows and Operational Mechanisms

Funding flows follow a multi-channel architecture illustrated in Figure 7.2. At the top, fiscal and concessional resources converge at BPDLH; mid-level line ministries execute CBT-coded programmes; and at the base, sub-national and community mechanisms ensure last-mile delivery. Key operational mechanisms include:

- **Integrated National Financing Framework (INFF):** aligns adaptation with macro-fiscal policy and medium-term expenditure frameworks.
- **Performance-Based Transfers:** incentivise local governments to integrate adaptation into plans and budgets.
- **Results-Based Finance:** funds released upon achievement of verified adaptation outcomes.
- **Revolving and Matching Funds:** encourage local co-financing and reinvestment in community resilience.

These instruments ensure that financing reaches all components of the NAP - governance, infrastructure, innovation, and community-level actions - without duplication or leakage. Financial institutions and the private sector are encouraged to support climate-resilient supply chains, including MSMEs developing drought- and flood-resistant seed varieties.

At the community level, the NAP further institutionalises adaptive financing through the use of Village Funds (Dana Desa) as mandated under Permendesa PDTT No. 2/2024 and Kepmendesa PDTT No. 501/2024. These regulations allow the prioritisation of Village Funds for climate adaptation activities – such as local water management, resilient agriculture

and early warning systems – while introducing performance-based incentives linked to the Village Climate Risk Index (IRID). This mechanism enables measurable and accountable adaptation financing at the village level, rewarding verified resilience outcomes. By linking fiscal transfers to risk reduction and community performance, the NAP strengthens bottom-up ownership, promotes inclusive participation, and supports the achievement of climate-resilient villages under the RPJMN 2025–2029.

7.5.6 Financial Accessibility and Vertical Integration

Ensuring access to finance across governance levels is critical for equitable operationalisation. The NAP therefore establishes differentiated access windows within the national system:

Table 7.5 Financial instruments across different actor levels

Actor level	Access modality	Examples of financial instruments
National ministries and agencies	Direct budget allocation through CBT-coded programmes and BPDLH grants.	Line-ministry appropriations, results-based payments.
Provincial / district governments	Earmarked transfers and matching grants linked to AKSARA integration scores.	Climate-performance incentives, fiscal reward schemes.
Local communities / CSOs	Micro-grants, cooperative finance, and faith-based funds channelled through regional DLH and banks.	Village-fund reallocation, community revolving funds.
Private sector and MSMEs	PPPs, green credit lines, and guarantee funds co-managed with OJK.	ESG investment windows, climate insurance.
Academia and innovation hubs	Competitive R&D grants and adaptation venture funds via NIPCA.	Technology development and scaling grants.

Accessibility criteria include transparency, gender responsiveness, and inclusion of small islands and remote areas. Financial intermediation by BPDLH and regional banks reduces transaction costs and bridges the gap between national budgets and local implementation. Community and faith-based financing — including zakat-linked resilience funds and CSR initiatives — extend the reach of finance to micro actors and households. Together, these channels form a vertically integrated system that balances national efficiency with local equity.

7.5.7 Analytical Reflection and Outlook to 2035

Indonesia's adaptation-finance system shows three distinct strengths:

- **Systemic integration**: finance is mainstreamed within planning and budgeting, not treated as a separate funding silo.
- **Investment leverage**: strategic use of public resources catalyses private capital and international support.

- **Transparency and equity**: SRN-PPI and performance-based transfers ensure accountability and inclusive access.

Financial transparency and oversight are jointly coordinated by KLH/BPLH, Kemenkeu and Kemen PPN/Bappenas under the national MEL framework, ensuring consistency between financial flows, reporting and adaptive decision-making. Remaining challenges include limited volume relative to adaptation needs, uneven sub-national capacity, and under-developed impact metrics for resilience returns. Addressing these through fiscal policy reform, capacity building and data standardisation will be the priority for the next cycle (2031–2035). By 2035, Indonesia aims to operate a fully mature adaptation finance system – where public spending is efficient, private investment is crowded in, and financial access is open to every level of governance and society. Sustaining this system depends on institutional capacity and participation, which are addressed in Section 7.6.

7.6 Capacity and Participation for Delivery

Building and sustaining adaptive capacity is fundamental to the operationalisation of Indonesia's NAP. Capacity and participation are not stand-alone activities but *means of implementation* that transform policies, finance, and technologies into results. This section outlines how Indonesia strengthens institutions, human resources, and stakeholder participation to ensure the NAP functions effectively from 2026 to 2035, in alignment with the Enhanced Transparency Framework (ETF) under Article 13 of the Paris Agreement.

7.6.1 Strategic Objective and Context

The overarching objective is to strengthen Indonesia's ability to plan, implement, and learn from adaptation actions through coordinated institutions, competent people, and inclusive participation. Under the ETF, capacity building supports transparency of action and support, while participation ensures ownership and accountability. Indonesia's approach rests on three inter-connected principles:

1. **Institutional readiness**: aligning mandates and coordination across sectors and levels of government;
2. **Human and technical competence**: equipping officials and practitioners with the skills to design, finance, and manage adaptation; and
3. **Inclusive engagement**: ensuring communities, private actors, and civil society participate meaningfully in adaptation planning and delivery.

These principles guide national and sub-national initiatives so that adaptation becomes a shared, continuous process rather than a sequence of isolated projects.

7.6.2 Institutional and Stakeholder Framework

Institutional coordination provides the foundation for operational delivery. At the national level, the KLH/BPLH leads adaptation policy and reporting; Kemen PPN/Bappenas integrates adaptation into AKSARA planning instruments; Kemenkeu ensures fiscal coherence through Climate Budget Tagging (CBT); and BPDLH mobilises and channels domestic and international finance. Sectoral ministries – agriculture, water, energy, health, environment and forestry – translate these frameworks into sector-specific programmes supported by local implementation mechanisms.

Sub-national governments, through provincial and regency/municipal development planning agencies, coordinate adaptation priorities consistent with national guidance. Community-based and village-level mechanisms – such as ProKlim, Desa Tangguh Iklim and Sekolah Hijau – serve as operational entry points that link local knowledge with national policy. These initiatives provide structured participation, technical training and demonstration sites for resilient livelihoods. Recognise local adaptation initiatives such as ProKlim and community-based spring restoration as national best practices and integrate them into the SRN-PPI registry. Professional and private-sector participation is encouraged through recognised associations (engineering, agriculture, health, environmental management) that collaborate with KLH/BPLH and Kemen PPN/Bappenas to provide technical advice and promote ethical practice. This partnership ensures that adaptation delivery meets professional standards while remaining inclusive of communities and small enterprises.

Weaving Traditional Fabric, West Kalimantan © SASCI+, GIZ,

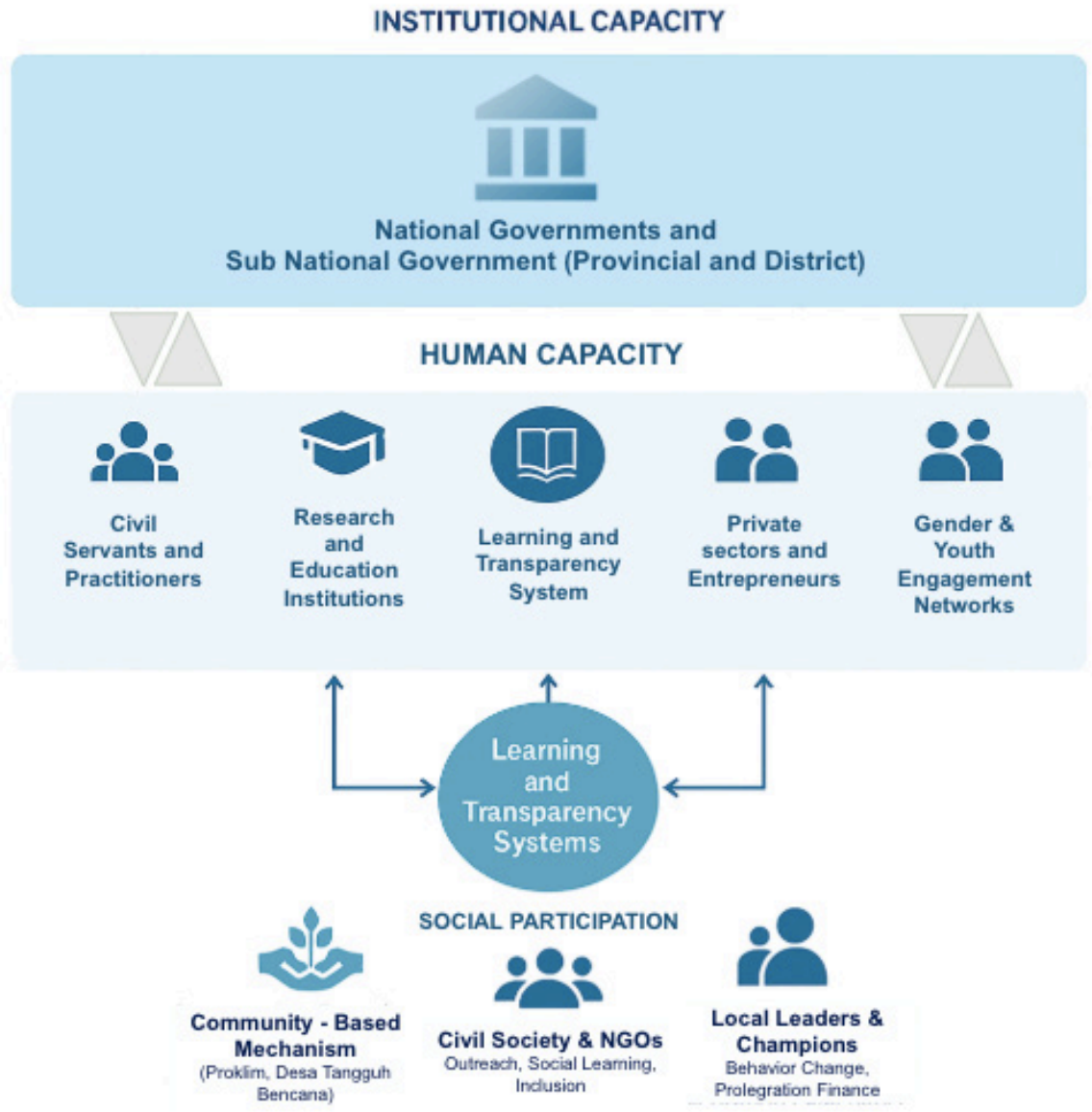


Figure 7.5 ***National capacity and participation framework for adaptation delivery***

The national capacity and participation framework for adaptation delivery, as depicted in Figure 7.5, is built upon three mutually reinforcing fundamental tiers: Institutional capacity, human capacity, and societal participation. At the institutional capacity tier, the respective institutions establish strategic and policy frameworks, wherein national coordination and fiscal management provide direction for regional governments as the primary implementers at the sub-national level. This strategic framework is then operationalised by strengthening the human capacity tier, which serves as the engine of the system. The core of this tier is a centralised learning and transparency system (encompassing the Adaptation Window and SRN-PPI), which serves as a node for collaboration and knowledge exchange among a diverse range of actors – from civil servants, research and education institutions, and the

private sector, to gender and youth networks. The coordinated collective action of these stakeholders is subsequently channelled to empower the societal participation tier at the grassroots level. The most crucial aspect of this architecture is its cyclical nature. Data and lessons learned from community-level implementation become essential feedback that is channelled back into the learning and transparency system. This feedback serves to continuously refine strategies and policies at the institutional level, thereby creating a sustainable and evidence-based adaptive governance cycle.

7.6.3 Priority Capacity and Participation Measures

To operationalise the NAP effectively, Indonesia will prioritise five mutually reinforcing capacity and participation measures:

1. **Strengthening institutional coordination:** Developing long-term collaboration between national and sub-national agencies through clear mandates, shared information systems, and regular coordination forums.
2. **Enhancing human-resource competence:** Providing targeted training in climate-risk assessment, planning, and finance for civil servants and practitioners, supported by partnerships with universities and training institutions.
3. **Promoting inclusive participation:** Scaling up ProKlim and related initiatives to ensure active involvement of women, youth, children, persons with disabilities and vulnerable groups in identifying and implementing local adaptation solutions within a gender-responsive and inclusive framework monitored through ETF capacity indicators.
    - **Expanding the definition of vulnerable groups** to explicitly include children, persons with disabilities, and the elderly within stakeholder mapping to ensure comprehensive inclusion in adaptation planning.
    - **Integrating climate literacy** into the national curriculum for primary and secondary education to build early awareness and adaptive skills, and promoting climate education from early childhood learnng (PAUD) through tertiary levels to build long-term resilience mindsets.
    - **Encouraging youth representation** in local adaptation planning processes to enhance inclusive decision-making.
4. **Encouraging private-sector engagement:** Facilitating investment partnerships, innovation challenges, and corporate social-responsibility programmes aligned with national adaptation priorities.
5. **Creating an enabling environment:** Fostering inter-sectoral collaboration, data sharing, and institutional flexibility so that adaptation responses remain responsive to evolving climate risks.

These measures emphasise systemic capacity rather than isolated training. They rely on government coordination supported by communities, research institutions, and the private sector, ensuring that adaptation actions are locally relevant yet nationally coherent.

7.6.4 Knowledge, Learning, and Digital Ecosystem

Continuous learning underpins long-term capacity enhancement. Indonesia's knowledge and learning system connects institutions, academia and communities through both physical networks and digital platforms. The Adaptation Platform, managed by KLH/BPLH, functions as the national gateway for adaptation information and learning. It links three key systems – AKSARA (for planning and investment pipelines), CBT (for budgeting and finance tracking), and SRN-PPI (for registration of adaptation actions). Through the Adaptation Platform, users can access open data, training materials, policy guidance and examples of local good practice. Integration with universities, research centres, and sub-national governments ensures that knowledge flows in both directions – from national policy to community innovation and vice versa. The platform embodies ETF principles by promoting transparency for learning, not for compliance. Information shared through the Adaptation Platform supports continuous improvement of national and local adaptation capacities and encourages partnerships with international knowledge networks..

7.6.5 Analytical Reflection, Gaps, and Outlook to 2035

Indonesia's institutional framework, fiscal systems, and participatory mechanisms collectively provide a strong foundation for delivering the NAP. Finance (Section 7.5) and technology (Section 7.4) supply the resources and tools, while capacity and participation ensure these resources are used effectively and inclusively. The system links top-down coordination with bottom-up initiative, ensuring that adaptation remains both nationally strategic and locally grounded.

Gaps and needs. Despite significant progress, several challenges remain:

- **Institutional continuity:** Coordination between ministries and local governments varies in effectiveness; dedicated budget lines for coordination and technical assistance are required.
- **Human resource distribution:** Technical expertise is concentrated in major cities; provincial and regency/municipal governments need sustained training and career incentives.
- **Knowledge accessibility:** While the adaptation platform improves access, its reach to remote and island regions should be expanded through regional nodes and offline materials.
- **Inclusivity:** Gender-responsive and youth-focused approaches must be mainstreamed across adaptation planning and implementation.
- **Sustained funding for capacity building.** Most training relies on short-term projects; integrating capacity indicators into performance-based transfers will secure continuity.

Outlook to 2035: Through the ETF improvement cycle (BTR →Global Stocktake →NAP Update), Indonesia will progressively strengthen institutional and technical capacity, aiming for:

- fully functional coordination mechanisms at all government levels;
- a skilled adaptation workforce across sectors;
- operational partnerships with communities and the private sector; and
- a national learning ecosystem anchored in the adaptation platform.

Monitoring, evaluation, and learning arrangements for these capacity measures are detailed in Chapter 8, ensuring that future improvements are guided by evidence and collective learning.

7.7 Summary of Key Instruments and Next Steps

Operationalizing Indonesia's NAP requires an integrated system of institutions, technologies, finances, and capacities that function coherently through time. This section summarises the key operational architecture established in Sections 7.1–7.6 and outlines the national pathway to 2035, linking Indonesia's adaptation framework with the Paris Agreement's Enhanced Transparency Framework (ETF) and national development planning horizons.

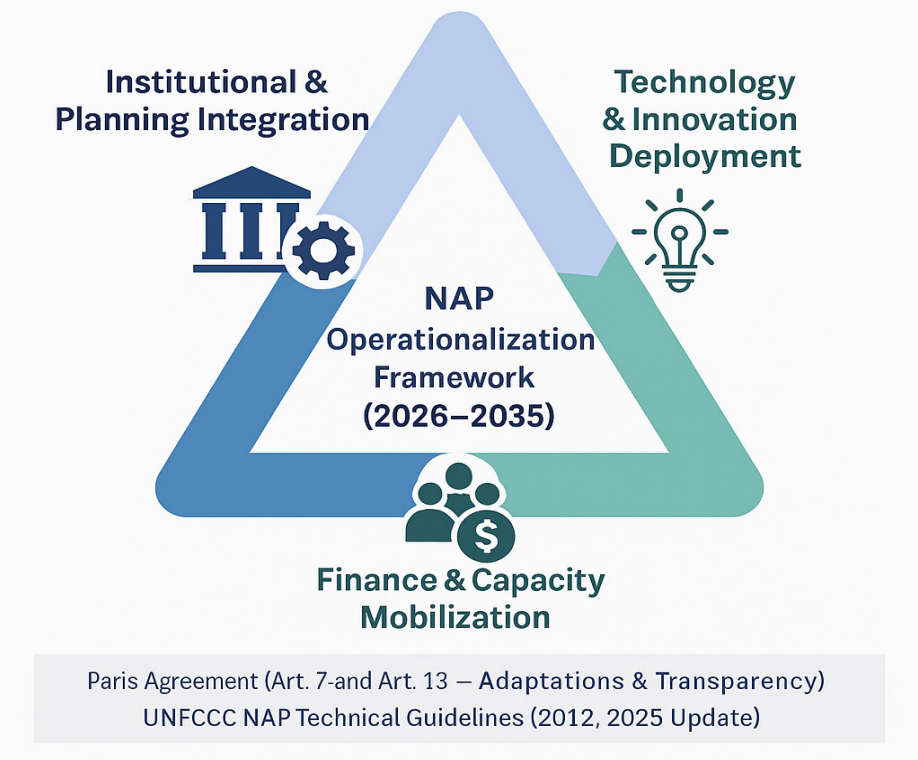


Figure 7.6 ***Three pillars of NAP Operationalisation***

The operational framework for Indonesia's NAP for the 2026–2035 period is designed as an integrated system to translate climate policy into coordinated action. This framework is supported by three interlinked pillars. The first pillar – institutional and planning integration – ensures that adaptation priorities are embedded within national and sub-national planning instruments, such as AKSARA, the RPJMN 2025–2029 and the RPJPN 2025–2045. The second pillar – technology and innovation development – focuses on the deployment of climate-resilient technologies and infrastructure solutions, supported by knowledge networks. The third pillar – finance and capacity mobilisation – aims to ensure the availability of the resources, skills and participation required for implementation across all levels of government and communities. Collectively, these three pillars form a system with a whole-of-government and whole-of-society approach. This approach enables Indonesia to achieve measurable adaptation outcomes while concurrently pursuing continuous improvement in line with the cycles of the Paris Agreement's Enhanced Transparency Framework (ETF).

7.7.1 Overview and Strategic Purpose

Chapter 7 has outlined the operational pillars that transform the National Adaptation Plan (NAP) from strategy to implementation—finance, technology, and capacity. Section 7.4 described how technological innovation and resilient infrastructure provide the enabling backbone; Section 7.5 detailed the financing architecture that aligns national budgeting with international mechanisms; and Section 7.6 demonstrated how institutional and human capacities anchor these systems to deliver measurable outcomes. This concluding section synthesizes those elements and sets out Indonesia's next steps toward 2035, identifying remaining gaps, concrete needs, and opportunities for resource mobilization so that government, private sector, academia, and development partners can contribute coherently to the NAP's operationalisation.

Indonesia's NAP 2026–2035 provides the strategic mechanism for translating climate policy into coordinated action. Its operationalisation rests on three interlinked pillars:

1. **Institutional and planning integration** – ensuring that adaptation priorities are embedded within national and sub-national planning instruments (AKSARA, RPJMN 2025–2029, and RPJPN 2025 - 2045).
2. **Technology and innovation deployment** – enabling sectors to apply climate-resilient technologies and infrastructure solutions supported by knowledge networks.
3. **Finance and capacity mobilization** – ensuring resources, skills, and participation are available for implementation across government levels and communities.

Together, these pillars form a whole-of-government and whole-of-society system that allows Indonesia to deliver measurable adaptation outcomes while continuously improving through ETF cycles. The operational cycle is underpinned by the AKSARA–CBT–SRN-PPI linkage, BPDLH

intermediation, and the national MEL ecosystem, ensuring a continuous plan–budget–register–learn loop that connects national systems with sub-national delivery mechanisms.

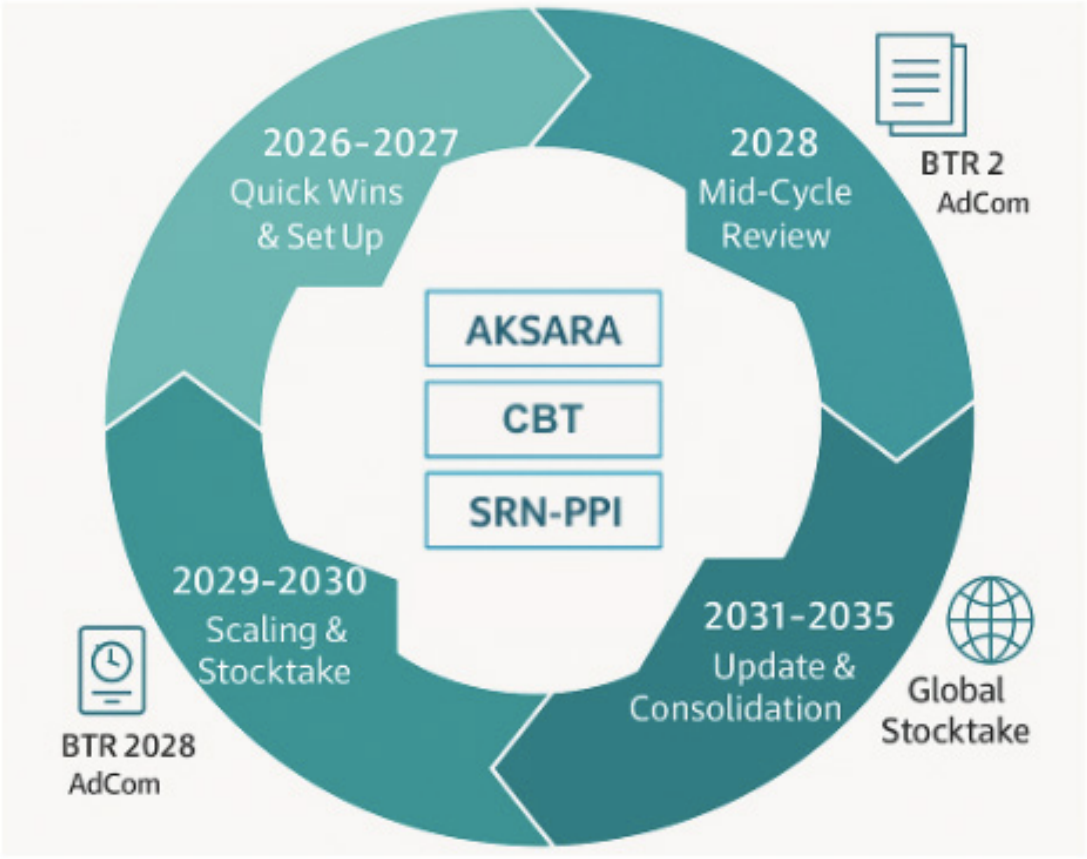


Figure 7.7 ***NAP operational cycle 2026–2035***

Figure 7.7 illustrates the operational cycle for NAP implementation, designed as an iterative governance approach comprising four phases to ensure continuous learning and refinement. The first phase – Quick Wins and Set-Up (2026–2027) – focuses on establishing institutional readiness and technical systems, including integrating adaptation priorities into the RPJMN and operationalising the SRN PPI as a national knowledge hub. This is followed by the Mid-Cycle Review (2028), where early implementation is evaluated and its results are reflected in the Biennial Transparency Report (BTR) and an updated Adaptation Communication (AdCom). The third phase – Scaling and Stocktaking (2029–2030) – aims to expand effective interventions and align national efforts with the Global Stocktake (GST) process. The cycle concludes with the Update and Consolidation (2031–2035) phase, which involves preparing an updated NAP (NAP Update 2031) by integrating all lessons learned into the subsequent RPJMN cycle (2030–2034). This entire cycle – planning, implementing, learning and updating – ensures that Indonesia's NAP remains a dynamic and responsive document to evolving risks and knowledge.

7.7.2 Operational Cycle 2026–2035

The implementation of the NAP will proceed through **four phases**, each contributing to sustained learning and refinement.

Table 7.6 NAP implementation phases

Phase	Period	Main purpose	Key activities and deliverables
Phase 1 – Quick Wins and Set-Up	2026–2027	Establish institutional readiness and technical systems for coordinated implementation.	Finalise institutional arrangements and MoUs; integrate adaptation priorities into RPJMN and sectoral plans; operationalise *adaptation platform* as national knowledge hub; initiate capacity and finance pipelines through CBT and BPDLH.
Phase 2 – Mid-Cycle Review and Alignment	2028	Evaluate early implementation and strengthen coherence with national development goals.	Undertake NAP mid cycle review; update Adaptation Communication (AdCom 2028); reflect results in Biennial Transparency Report (BTR 2028).
Phase 3 – Scaling and Stocktaking	2029–2030	Scale effective actions and consolidate cross-sectoral partnerships.	Expand successful local and sectoral interventions; align with Global Stocktake (GST 2028–2030); mobilise blended finance for replication.
Phase 4 – Update and Consolidation	2031–2035	Prepare updated NAP ("NAP Update 2031") and institutionalise adaptive governance.	Incorporate lessons from evaluations; integrate with RPJMN 2030–2034; publish updated NAP and long-term adaptation strategy consistent with ETF.

This cycle reflects Indonesia's iterative governance approach - planning, implementing, learning, and updating - so that the NAP remains dynamic and responsive to emerging risks and knowledge.

7.7.3 Current Limitations and Gaps

Despite substantial progress, Indonesia's NAP process still faces several interlinked constraints that limit the full realization of adaptation outcomes.

Data and information continuity: The "dual-track" approach used in Chapter 3 - combining ideal, long-term NAP formulation with the practical realities of available evidence - revealed the uneven continuity between historical data, future projections, and quantified impact assessments. Climate datasets remain fragmented across institutions, while cross-sectoral linkages (e.g., between hydrology, agriculture, health, and energy) are only partially interoperable. Strengthening shared repositories and metadata standards is critical for developing cost-benefit and investment cases for adaptation portfolios.

Impact-to-investment translation: The step from assessing vulnerability to identifying investable adaptation options is not yet systematic. Many sectoral actions still stop at the policy or pilot level without bankable designs or economic valuation. The development

of national guidelines for adaptation cost modelling, risk transfer, and blended-finance mechanisms will ensure that adaptation options can progress into portfolio pipelines attractive to both domestic and international financiers.

Institutional fragmentation: While coordination has improved through the National Adaptation Committee, mandates for adaptation planning, budgeting and reporting remain dispersed. Clearer definition of lead and supporting roles across ministries – particularly for data governance, budgeting and MEL – will help maintain policy coherence and reduce overlap with mitigation programmes..

Capacity unevenness: Technical expertise and institutional readiness vary widely among provinces and sectors. Continuous professional training, provincial adaptation help-desks, and long-term career incentives are required to sustain local ownership beyond project cycles.

Financing limitations: Adaptation remains under-represented in national and sub-national budgets. Although Climate Budget Tagging (CBT) and AKSARA have begun to integrate adaptation, many line ministries still rely on external grants for pilot activities. Embedding adaptation indicators in performance-based fiscal transfers will help mainstream adaptation spending across the national–sub-national interface

MEL alignment: Current monitoring systems emphasize activity completion rather than outcome learning. Harmonization with the forthcoming MEL framework (Chapter 8) will be necessary to track adaptation effectiveness and inform iterative NAP updates.

7.7.4 Needs and Opportunities for Resource Mobilisation

Indonesia's NAP can only succeed through broad collaboration that links policy, knowledge, finance, and community action. The following priority needs define where government leadership and external support can converge to strengthen national resilience and ensure long-term sustainability.

1. **Research and Development (R&D):** Investment in national and regional research consortia is required to refine climate-impact modelling, socio-economic scenario building, and sectoral cost–benefit analyses. Partnerships between KLH/BPLH, BMKG, BRIN, and universities should focus on downscaling projections, improving attribution of compound hazards, and quantifying avoided losses from adaptation actions.
2. **Technology transfer and digital innovation:** Targeted support is needed to expand the digital ecosystem as the unified platform for adaptation data, dashboards, and decision tools. Opportunities include remote-sensing applications for ecosystem monitoring, digital twin models for infrastructure stress testing, and early-warning integration for health and disaster management. Collaboration with private-sector technology providers can accelerate deployment while ensuring interoperability with national systems (SRN-PPI, AKSARA, CBT).

3. **Finance and investment pipelines:** To translate adaptation options into executable projects, Indonesia seeks blended-finance mechanisms that combine public expenditure, concessional loans, and private investment. Development partners can assist through feasibility studies, de-risking instruments, and access to global funds (GEF, Adaptation Fund, GCF). Domestically, innovative fiscal tools—green sukuk, adaptation bonds, and revolving funds—should be expanded. Integration of adaptation portfolios with the LTS-LCCR 2050 framework will also attract long-term, low-emission investment.
4. **Capacity development and learning:** Long-term fellowships, on-the-job technical placements, and community extension programmes will bridge knowledge gaps between national experts and local practitioners. Training modules on MEL Adaptation, gender-responsive planning and local climate-finance management should become part of regular civil-service curricula.
5. **Policy support and institutional strengthening:** Assistance in updating sectoral regulations, aligning sub-national planning instruments (RAD-API, RPJMD), and operationalising adaptation indicators within RPJMN 2025–2029 will consolidate the policy foundation. Coordination with Kemenkeu and Kemen PPN/Bappenas will ensure fiscal coherence and measurable outcomes.

These five domains collectively define the investment opportunities for Indonesia's adaptation agenda. Development partners are invited to align technical assistance and funding envelopes with these nationally articulated priorities to maximise coherence and impact. In parallel, Indonesia also integrates *Loss and Damage (L&D)* considerations within its learning and reporting cycle under the UNFCCC. While adaptation aims to reduce vulnerability and enhance resilience, L&D addresses residual impacts that occur when adaptive capacity is exceeded. Through coordination between KLH/BPLH and Kemen PPN/Bappenas, national reporting on L&D is aligned with the Adaptation Communication (AdCom) and Biennial Transparency Report (BTR), ensuring coherence with the global *Loss and Damage Fund* framework. Lessons from post-disaster recovery, livelihood restoration, and ecosystem rehabilitation are systematically captured within the MEL system and *Adaptation* platform to inform future adaptation planning. Integrating L&D into the NAP's implementation loop strengthens Indonesia's ability to quantify avoided losses, document residual risks, and mobilize both domestic and international support for long-term climate resilience.

7.7.5 Outlook to 2035 and Alignment with LTS-LCCR 2050

By 2035, Indonesia envisions an adaptation system that is fully integrated, evidence-based, and investment-ready. The following milestones illustrate this trajectory:

- **Institutional consolidation:** A stable governance framework linking KLH/BPLH (as national focal point) with coordinating ministries and sub-national governments ensures

that adaptation is embedded within national development and fiscal planning.

- **Investment readiness:** Each sectoral and cross-sectoral portfolio (Food, Water, Energy, Health, Ecosystem, DRM) will have costed and prioritized action pipelines linked to financing instruments and job-creation programs under the LTS-LCCR 2050.
- **Learning ecosystem:** Knowledge generated from R&D and MEL will inform periodic NAP updates, ensuring continuous refinement of adaptation targets, indicators, and funding strategies.
- **Inclusive participation:** Gender equality, youth engagement, and traditional knowledge integration become intrinsic to all adaptation programs, ensuring that adaptation delivers social justice alongside resilience.
- **Partnerships for scale:** Long-term cooperation with development partners, private investors, and civil society enables co-financing and technology exchange, turning adaptation into a driver of innovation and employment.

Through the ETF improvement cycle—BTR →Global Stocktake →NAP Update— Indonesia will continuously enhance institutional capacity, financing effectiveness, and transparency. Each cycle will provide an evidence base for scaling up adaptation ambition and aligning progress with the LTS-LCCR 2050 pathway.

7.7.6 Pathway to 2035 and Next Steps

The pathway to 2035 establishes a clear sequence for consolidating adaptation governance and institutional learning. To maintain coherence with government fiscal rhythms, this pathway aligns with the national decision cadence—monthly technical coordination, annual reviews synchronized with the RKP and APBN cycle, and five-year strategic reviews that feed into ETF and BTR reporting.

- **2026–2027 (Set-Up):** Finalise institutional structures, operationalise digital systems, secure financing pipelines, and launch initial capacity-building programmes.
- **2028 (Mid-Term Review):** Conduct NAP review, publish AdCom update, and integrate findings into BTR 2028.
- **2029–2030 (Scaling and Stocktake):** Expand effective programmes and partnerships, contribute to Global Stocktake, and document good practices.
- **2031–2035 (Update and Consolidation):** Prepare and submit NAP Update (2031), embed lessons into national planning cycles, and establish permanent adaptation capacity within institutions.

Throughout these phases, national instruments—AKSARA, SRN-PPI, CBT, and BPDLH—will continue to provide the enabling framework for transparent, inclusive, and evidence-based adaptation delivery. By 2035, Indonesia aims to operate a self-sustaining adaptation

governance system characterised by:

- enduring institutional coordination across sectors and levels;
- predictable finance and capacity flows;
- integrated technology deployment and innovation; and
- continuous learning embedded in public administration and society.

This marks the completion of the first full operational cycle of the NAP and the foundation for its next iteration, ensuring Indonesia's adaptation governance evolves alongside its development and climate ambitions. Monitoring, evaluation, and learning arrangements for this operational pathway are detailed in Section 8, which describes the national MEL framework for tracking progress and facilitating future updates.

Box 7.1 Pathway to 2035 and UNFCCC Linkages

Purpose: Summarizes Indonesia's forward-looking implementation cycle (2026 – 2035) and how it connects to UNFCCC transparency processes, ensuring learning continuity and iterative improvement.

Indonesia's NAP 2026 – 2035 Operational Pathway

Phase	Time Frame	Core Focus	Outputs / Milestones
1 – Quick Wins & Set-Up	2026–2027	Establish institutional readiness, finance channels, and digital systems (AKSARA, CBT, SRN-PPI, Adaptation Platform).	Institutional MoUs completed; ProKlim expansion; capacity baseline defined.
2 – Mid-Cycle Review	2028	Assess implementation progress and alignment with national planning (RPJMN 2025–2029).	NAP Mid-Term Review Report; integration into BTR 2028 and AdCom update.
3 – Scaling & Stocktake	2029–2030	Scale effective programmes and partnerships; link to Global Stocktake (GST 2028–2030).	Consolidated adaptation portfolio; lessons and case studies submitted to UNFCCC.
4 – Update & Consolidation	2031–2035	Prepare NAP Update 2031 and institutionalise continuous governance and learning.	Revised NAP and AdCom 2031; integration into RPJMN 2030–2034; enhanced ETF capacity.

UNFCCC Linkages

- **Adaptation Communication (AdCom):** Updated every five years to reflect NAP progress and emerging needs.
- **Biennial Transparency Report (BTR):** Captures adaptation actions, support mobilised, and capacity gaps; BTR 2028 and BTR 2032 will document NAP implementation results.
- **Global Stocktake (GST 2028–2030):** Aggregates global progress; Indonesia's MEL data from SRN-PPI and Adaptation Platform will inform the assessment.

Takeaway: This pathway embeds Indonesia's NAP within a continuous learning cycle—planning, implementation, review, and update—ensuring that domestic adaptation governance remains aligned with the Enhanced Transparency Framework and the Paris Agreement's long-term goals.

Aerial photo of mangroves in the Angke Kapuk Protected Forest, adjacent to the PIK residential area © Piarea, 2025

8

MONITORING, EVALUATION AND LEARNING (MEL)

8.1 Purpose and Legal Mandate

Monitoring, Evaluation and Learning (MEL) is the operational mechanism through which Indonesia measures the compliance and achievement of its National Adaptation Plan (NAP). It is not an additional reporting instrument, but the integrative governance system that connects policy targets with verified implementation results. Through MEL, adaptation becomes a measurable component of national development, anchored in existing administrative and legal frameworks rather than external project cycles. This structure reflects the principles of *country ownership, integration and iterative learning* outlined in the UNFCCC NAP Technical Guidelines (LEG, 2012; updated 2025) and aligns with Indonesia's commitment under Article 13 of the Paris Agreement to establish a nationally determined transparency framework.

At the sub-national level, regional action plans for climate change adaptation (RAD-API) serve as the primary instruments for implementing the NAP within provincial and regency/municipal contexts. Clarifying this linkage emphasizes that local governments are not only obligated to prepare RAD-API documents, but are also responsible for translating adaptation priorities into local actions and reporting their outcomes. Moreover, sub-national governments are expected to provide bottom-up feedback to the MEL system, ensuring that data and lessons from local implementation inform national planning and policy refinement. This feedback loop reinforces the decentralised nature of Indonesia's adaptation governance and promotes adaptive learning across administrative levels.

Utilizing used bottles for ornamental plants in Kamal Muara © Piarea, 2025

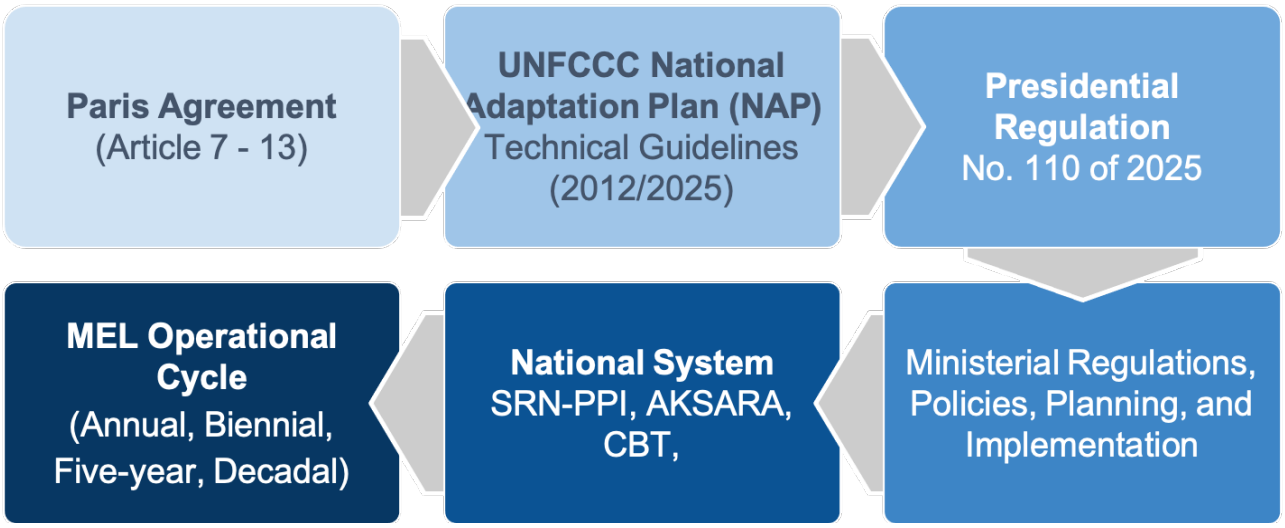


Figure 8.1 Legal–policy framework of the Monitoring, Evaluation and Learning (MEL) system in Indonesia

8.1.1 Legal Foundation and National Obligation

The legal mandate for MEL arises from the interlinked provisions of Presidential Regulation No 98/2021 as updated by Presidential Regulation No 110/2025 (Perpres 110/2025) and MOef Regulation No. 12/2024 (Permen LHK 12/2024). Articles 50 - 58 in Perpres 110/2025 require continuous *monitoring and evaluation* of national actions on mitigation, adaptation and carbon pricing (*nilai ekonomi karbon*/ - NEK). Monitoring and evaluation must encompass:

a. the national greenhouse gas inventory;
b. implementation of mitigation and adaptation;
c. operation of the carbon economic value mechanism;
d. the transparency framework; and
e. institutional oversight and capacity building.

These provisions also establish the national–provincial–regency/municipal hierarchy of responsibility: the Ministry of Environment (KLH/BPLH) coordinates nationally; line ministries undertake sectoral monitoring; governors lead provincial evaluation; and regents or mayors manage local implementation. The same regulation, in Article 79, obliges that monitoring and evaluation results be consolidated into a National Report on the Implementation of the NDC, formally submitted to the President through the Coordinating Minister. In effect, MEL operationalises this reporting obligation by defining how adaptation information flows, is verified, and is transformed into national evidence for accountability and planning.

Permen LHK 12/2024, Articles 90–94, translates this high-level mandate into detailed procedures. It specifies that monitoring and evaluation shall be conducted annually at

minimum, and that results cover three principal domains — policy, adaptation actions and capacity development. The regulation assigns responsibilities to the Minister, sectoral ministries, governors and regents/mayors, and stipulates that all results be entered in the National Registry System for Climate Change Control (SRN-PPI). Annex III provides the operational templates for data collection and evaluation, covering the five NAP sectors: food, water, energy, health and ecosystem (FWEHE). By legally codifying these procedures, the regulation transforms MEL from a conceptual framework into a nationally enforceable system.

8.1.2 Strategic Purpose within the NAP Framework

The function of MEL within the NAP is to ensure that adaptation planning, financing and implementation can be measured, verified, and learned from in an integrated way. Its design responds to three overarching questions:

1. To what extent are adaptation commitments implemented according to the NAP priorities and the Enhanced NDC?
2. How effectively do these actions enhance resilience in the FWEHE sectors and associated livelihoods?
3. How do monitoring results inform the next planning cycle and improve policy decisions?

Addressing these questions requires that monitoring and evaluation be embedded within national governance systems, not appended as donor-driven requirements. MEL therefore merges legal obligation (Presidential Regulation 110/2025), technical procedure (MoEF Regulation 12/2024), and international guidance (NAP Guidelines and ETF) into one integrated architecture. This integration ensures that the outcomes of adaptation measures are reflected in the AKSARA planning database of The Ministry of National Development Planning (Bappenas), the CBT financial tagging system of the Ministry of Finance (Kemenkeu), and the SRN-PPI registry of Ministry of Environment/Environmental Protection Agency (KLH/BPLH). Together these systems provide a single evidence base linking policy performance, resource allocation and verified outcomes.

8.1.3 Analytical Justification: From Compliance to Governance

The justification for MEL lies in the transition from fragmented project reporting to an adaptive governance cycle. Legally, it satisfies the requirement of *monitoring and evaluation* under Article 50 in Perpres 110/2025. Institutionally, it positions Indonesia to meet the Enhanced Transparency Framework (ETF) by producing measurable, consistent, and comparable information on adaptation progress. Administratively, it makes use of digital platforms already mandated by national regulation, ensuring feasibility and

efficiency without establishing parallel systems. Analytically, MEL performs three interlinked governance functions:

- Measurement: converting adaptation targets into quantifiable indicators defined under Permen LHK 12/2024 Annex III;
- Verification: ensuring the integrity of information through multi-tier validation (local, provincial, national); and
- Learning: transforming evaluation results into policy adjustments and institutional guidance.

This tripartite function corresponds to the "monitor–evaluate–learn" continuum prescribed by the 2025 NAP Guideline. It transforms compliance into continuous improvement, allowing adaptation targets to evolve with changing climate, socio-economic and technological contexts. By integrating its legal mandates and operational systems, Indonesia ensures that MEL is not merely a measurement tool, but an expression of national governance maturity. It aligns domestic law with international expectations while maintaining national control over data, verification and reporting. The system thus constitutes the foundation upon which the following subsections — detailing institutional operation, scope, cycles, and transparency — are built.

Table 8.1 Legal and Institutional Anchors of the Monitoring, Evaluation, and Learning (MEL) Framework

Legal Instrument	Relevant Article(s)	Key Provision / Content Summary	Operational Implication for MEL
Perpres No. 110/2021 on Carbon Governance	Articles 50-58 dan 90-92	Mandates the monitoring and evaluation of mitigation, adaptation, and the implementation of carbon economic value (NEK) to ensure the achievement of the 2030 NDC targets; defines vertical responsibilities across KLH/BPLH, sectoral ministries, governors, regents/ mayors (RAD-API) and business entities; and requires national reporting to the President	Establishes MEL as a legally binding national obligation for tracking adaptation progress and transparency; provides the statutory basis for a multi-level monitoring system and periodic national reporting cycles under the NDC framework
	Articles 75-86	Regulates transparency and the national Measurement, Reporting, and Verification (MRV) procedures for all climate actions, including validation, verification, and publication of data through the *National Registry System for Climate Change Control* (SRN-PPI).	Provides the technical and institutional foundation for MEL's data governance and quality assurance, ensuring consistency with the Enhanced Transparency Framework (ETF) under Article 13 of the Paris Agreement.
Permen LHK No. 12/2024 on Implementation of the Nationally Determined Contribution in Addressing Climate Change	**Articles 90–92**	Specifies that monitoring and evaluation of climate change adaptation shall be carried out at the national, provincial and regency/municipal levels; defines the three main monitoring objects: (a) policy, (b) adaptation actions, and (c) capacity development	Operationalises the three-tier MEL structure (national–provincial–local) and clarifies institutional responsibilities for data collection, aggregation and verification in accordance with national law

Legal Instrument	Relevant Article(s)	Key Provision / Content Summary	Operational Implication for MEL
	Articles 93–94	Requires annual reporting of monitoring and evaluation results through the SRN-PPI. Refers to *Annex III* as the official format for data submission, reporting and verification	Establishes MEL's reporting frequency, data-management procedures and verification standards, ensuring alignment of sub-national and national data flows
	Annex III	Provides standardised templates and indicator sets for monitoring and evaluation of adaptation, including data fields for policy instruments, adaptation actions, adaptive technology, financing sources and beneficiaries	Serves as MEL's operational manual for implementation, linking each indicator to its responsible agency and corresponding verification level
UNFCCC and NAP Technical Guidelines (Least Developed Countries Expert Group, 2012; updated 2025)	**Sections 83–93**	Outline the international principles of monitoring, evaluation, learning, and iterative improvement within national adaptation processes; requires integration of national systems with the Enhanced Transparency Framework and alignment of domestic MEL structures with Article 13 of the Paris Agreement	Provide normative alignment and technical consistency for MEL design, ensuring that Indonesia's nationally mandated system also satisfies international reporting, comparability and transparency requirements

8.2 Institutional Operation and Data Flow

The operational design of Indonesia's MEL system reflects the country's administrative structure and legal mandates. It establishes a coherent chain of accountability that connects local implementation with national decision-making, ensuring that every adaptation result — whether regulatory, technical, or financial — can be traced from its origin in the field to its registration at the international level. This configuration embodies the principle of *integration across levels of governance* prescribed in the UNFCCC NAP Guidelines (2025 update) and translates it into a legally binding architecture defined by Presidential Regulation No 110/2025 and MoEF Regulation No 12/2024.

Community based monitoring, West Kalimantan © SASCI+, GIZ, 2025

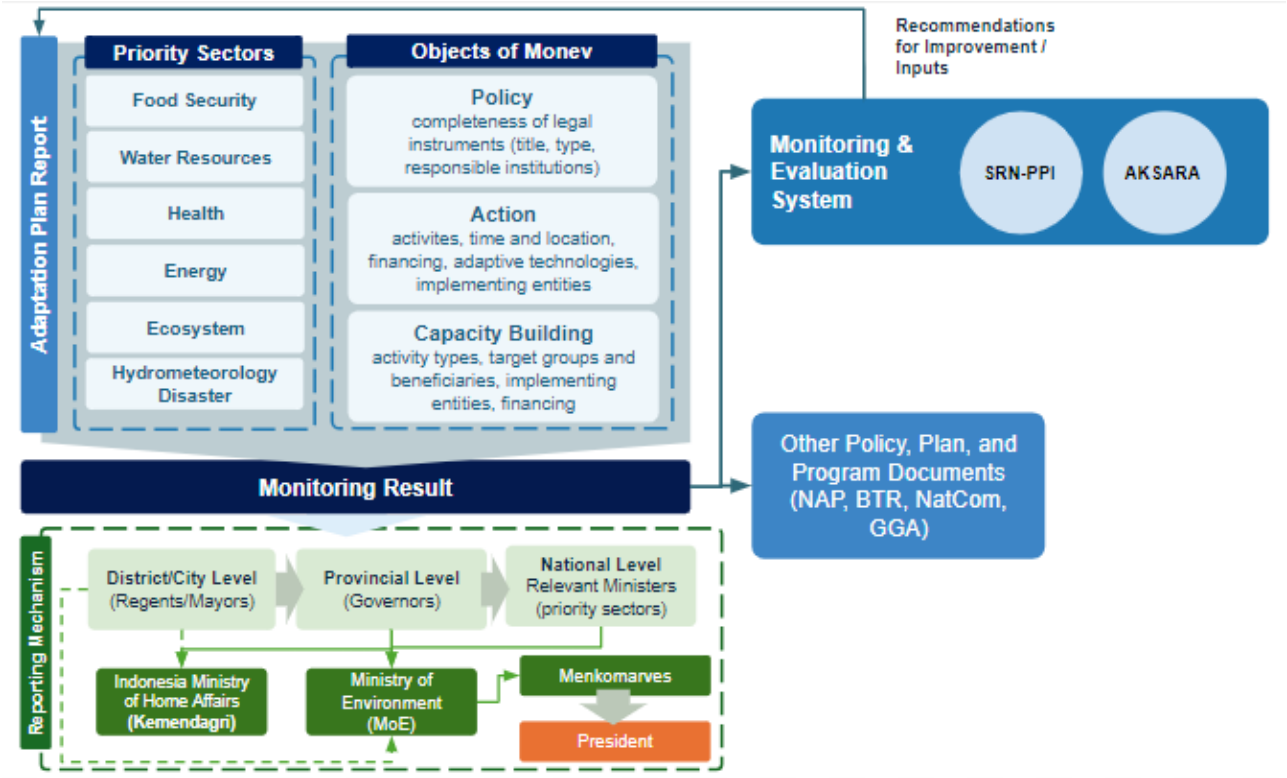


Figure 8.2 Institutional architecture and data flow of the Monitoring, Evaluation, Accountability and Learning (MEL) system

The system functions by monitoring the Adaptation Plan Report across priority sectors (such as food security, water resources and health), with evaluation objects that include policy, action, and capacity building. These monitoring results are then fed into the national monitoring and evaluation system (using the SRN-PPI and AKSARA platforms) to generate recommendations for improvement, which serve as inputs for future planning and other policy documents. This process is supported by a tiered reporting mechanism that starts at the regency/municipal level, moves up to the provincial level, and then to the national level through relevant ministries (coordinated by the Ministry of Home Affairs (Kemendagri) and KLH/BPLH, with a final report submitted to the President, thereby creating a structured flow of data and accountability from the regional to the central level. The institutional distribution of roles and responsibilities across the MEL system is presented in Table 8.2.

A fisherman in Wakatobi © UNDP Indonesia, 2025

Table 8.2 Roles and responsibilities in MEL implementation (RACI matrix)

MEL function	Accountable	Consulted	Responsible	Supporting	Informed
Strategic coordination and oversight	Ministry of Environment (KLH/BPLH) – National Focal Point to the UNFCCC; leads the national MEL system and validates results for submission under the Enhanced Transparency Framework (ETF)	Coordinating Ministry for Food Affairs (formerly Maritime Affairs) for policy alignment; Ministry of Home Affairs for sub-national governance	Bappenas for alignment with national development planning; Ministry of Finance (Kemenkeu) for budget and resource mobilisation coherence	National MEL Steering Committee and relevant inter-ministerial task forces	All line ministries, provincial and regency/ municipal governments, civil-society organisations (CSOs), and the public through the *Adaptation Platform*
Planning and performance integration	KLH/BPLH jointly with Bappenas and Kemendagri	Kemenkeu; sectoral ministries (Agriculture, Public Works, Energy, Health, Forestry)	Bappenas and Kemendagri manages the AKSARA planning database and integrates MEL findings into RPJMN/ RPJMD development plans	Sub-national governments (Bappeda, environment offices)	National Development Council, local development planning bodies, and the public
Financial tracking and reporting	Kemenkeu	KLH/BPLH, Bappenas, and provincial finance offices	Directorate of Budgeting and the Directorate of Climate Finance and Multilateral Cooperation under Kemenkeu – maintains the Climate Budget Tagging (CBT) system	Line ministries and regional treasuries reporting expenditure data for adaptation programmes	President and Coordinating Ministers through annual financial performance reports
Data collection, verification and registry Management	KLH/BPLH – Directorate General of Climate Change Control.	Bappenas and Kemenkeu to ensure data alignment with AKSARA and CBT	Sectoral ministries – collect, verify and submit data on adaptation actions and indicators to SRN-PPI	Meteorology, Climatology and Geophysics Agency (BMKG) for climate and weather data; National Disaster Management Agency (BNPB) for disaster impact data; Statistics Indonesia (BPS) for socio-economic data	Sub-national governments, academia, private sector and CSOs via open data access in *Adaptation Platform*
Monitoring and evaluation (M&E) of adaptation actions	KLH/BPLH – consolidates and validates national results	Sectoral ministries for technical consistency and provincial governments for territorial accuracy	Provincial environment offices (DLH) – coordinate local data aggregation; RAD-API progress; regents/ mayors lead regency/ municipal evaluation in line with *Permen LHK 12/2024* Articles 90–92	Local agencies (public works, agriculture, health, fisheries); research institutions assisting data analysis	National MEL Working Group and local adaptation stakeholders

MEL function	Accountable	Consulted	Responsible	Supporting	Informed
Learning – and capacity development	KLH/BPLH and Bappenas (joint coordination)	Universities, professional associations, private sector and CSOs	MEL Review and Learning Workshop Secretariat under KLH/BPLH	Provincial training centres and technical agencies	All participants through Learning Notes disseminated on the *Adaptation Platform*
Transparency, reporting and communication	KLH/BPLH – accountable for national MEL transparency under Presidential Regulation 98/2021 Articles 60–68.	Bappenas (for development alignment), Kemenkeu (for finance disclosure), and Coordinating Ministry for Food Affairs (Kemenko Pangan)	KLH/BPLH – prepares the National Adaptation Progress Report (NAPR) and inputs for BTR and AdCom	Communication units within KLH/BPLH and provincial DLHs	General public, international partners and the UNFCCC Secretariat
Policy feedback and continuous improvement	KLH/BPLH as lead agency for MEL governance	Bappenas and Kemenkeu for integration into planning and budgeting cycles	Line ministries and provincial governments – implement policy adjustments based on MEL findings	Technical Working Groups on Adaptation Indicators and Monitoring Systems	National MEL Steering Committee and public reporting platforms
Mainstreaming gender and child protection	Ministry of Women Empowerment and Child Protection (Kemen PPPA) – responsible for integrating gender and child protection considerations into the MEL framework	Coordinating Ministry for Human Development and Culture (Kemenko PMK) for policy alignment; Kemendagri for sub-national coordination	Kemen PPPA for ensuring gender and child protection are mainstreamed in MEL reporting and evaluation processes; National Commission on Human Rights (Komnas HAM) for human rights considerations	National MEL Steering Committee and relevant task forces for monitoring progress and ensuring integration	Provincial and regency/ municipal governments, CSOs and the public through the Adaptation Platform

8.2.1 Vertical Coherence: Chain of Responsibility

Article 90 of Presidential Regulation 110/2025 assigns the Minister of Environment as the national coordinator for monitoring and evaluation of adaptation, working in concert with sectoral ministers, governors, and regents or mayors. The regulation stipulates that the monitoring of adaptation implementation shall encompass not only technical actions but also the transparency framework, capacity-building and oversight mechanisms. Article 90 of Permen LHK 12/2024 refines this mandate by detailing the hierarchy of responsibility:

1. the Minister of Environment supervises monitoring and evaluation at the national level;
2. sectoral ministers perform monitoring within their respective portfolios;
3. governors coordinate implementation and reporting across provincial agencies; and
4. regents or mayors conduct the same within their jurisdictions.

This vertical arrangement ensures that monitoring is not a one-directional reporting exercise, but a feedback system in which each administrative tier verifies, synthesises and learns before transmitting information upward. In practice, data on adaptation actions — such as ecosystem restoration, resilient agriculture, or urban drainage upgrades — are

first recorded by the executing agencies at the regency or municipal level. Provincial environment offices (DLHs) then aggregate and verify the information, applying quality-control standards consistent with Annex III of Permen LHK 12/2024. The verified data are forwarded to the relevant sectoral ministries, which conduct consistency checks against national targets and submit consolidated sectoral reports to the KLH/BPLH. The final synthesis constitutes the official national adaptation dataset stored in the SRN-PPI.

The logic of this multi-tier structure lies in administrative legitimacy. Each level operates within its legal competence, which prevents data duplication and reinforces ownership. Governors and regents or mayors are not passive transmitters of information; they are mandated evaluators under Article 91 of Permen LHK 12/2024, responsible for validating whether actions correspond to local development priorities and whether budget execution complies with environmental accountability standards. This design transforms monitoring into an element of local governance rather than an external audit.

8.2.2 Horizontal Integration: Planning, Finance, and Registry

To ensure that monitoring results influence decision-making, MEL establishes horizontal linkages among three national systems:

1. **AKSARA**, the planning and performance information platform managed by Bappenas;
2. **CBT**, the climate budget tagging database managed by Kemenkeu; and
3. **SRN-PPI**, the climate-action registry administered by KLH/BPLH.

These systems form a continuum — from planning, to financing, to verification — that mirrors the workflow of adaptation implementation. Each system maintains its institutional autonomy, but exchanges datasets through standardised identifiers and metadata protocols. Information on approved adaptation projects in AKSARA is cross-checked with financial disbursement records in CBT and subsequently validated in SRN-PPI upon completion. This triangulation produces a single verified dataset that supports both domestic reporting and international transparency submissions.

Article 87 of Presidential Regulation 110/2025 requires that results of monitoring and evaluation from all actors — government and business — be consolidated into a national report on the implementation of the NDC, submitted annually to the President through the coordinating minister. MEL operationalises this requirement by synchronising the three systems above. The national report generated by KLH/BPLH is automatically supported by financial evidence from CBT and planning evidence from AKSARA, ensuring that adaptation performance is demonstrably linked to resource allocation. This integrated approach meets the UNFCCC Enhanced Transparency Framework criterion of *consistency and comparability* (Decision 18/CMA.1).

8.2.3 Functional Roles and Collaborative Mechanisms

Within this institutional ecosystem, responsibilities are distributed according to the RACI logic — Responsible, Accountable, Consulted and Informed:

- **Accountable:** KLH/BPLH, serving as National Focal Point, is legally accountable for consolidating and validating MEL results, producing the national adaptation report, and ensuring submission through the UNFCCC vehicles (AdCom, BTR).
- **Consulted:** Bappenas and Kemenkeu, as custodians of planning and finance, are formally consulted to ensure that MEL findings feed back into policy revision and budget realignment.
- **Responsible:** line ministries — Agriculture, Public Works (PU), Energy and Mineral Resources (ESDM), Health and Forestry — are responsible for data collection and sectoral validation in the five priority domains of the NAP (food, water, energy, health, ecosystem).
- **Supporting:** technical agencies — BMKG for climate data, BNPB for disaster impact data, KemenPPPA for gender and vulnerable groups mainstreaming aspects, and BPS for socio-economic statistics — provide baseline and periodic datasets used to interpret adaptation outcomes.
- **Informed:** provincial and local governments, civil society organisations, academic institutions and private sector partners are informed and engaged through annual MEL review meetings and the Adaptation Platform portal.

This distribution of roles ensures that monitoring and evaluation are not confined to environmental agencies, but constitute a *whole-of-government process*. It institutionalises cooperation without diluting accountability: each actor's role is defined by existing statutory authority, which guarantees enforceability under Indonesian administrative law.

8.2.4 Operational Dynamics and Verification Integrity

The credibility of MEL rests on how data move through the system. Verification operates at two levels. First, technical validation by sectoral ministries checks accuracy and methodological conformity with the indicators described in Chapter 6 of the NAP. Second, procedural validation by KLH/BPLH ensures that data entered in SRN-PPI follow the national MRV protocol outlined in Presidential Regulation 110/2025 Article 75 and 86. Independent reviewers — universities and professional associations — may be engaged under ministerial decree to strengthen the transparency and objectivity of the verification process.

Because all records are hosted on digital platforms integrated with the government's single-sign-on system, MEL ensures traceability and minimises manual reporting burdens. The approach is both rigorous and pragmatic: rigorous because it follows codified standards,

and pragmatic because it leverages tools already operational within government infrastructure.

8.3 Scope of Monitoring and Evaluation

The scope of Indonesia's MEL system defines what is measured to determine the degree of compliance and achievement in implementing the NAP. It clarifies the dimensions through which adaptation results are tracked, verified and interpreted to assess how policies, actions and institutional capacities contribute to national resilience objectives. The arrangement follows Article 91 of Permen LHK No. 12/2024, which directs that monitoring and evaluation of adaptation shall cover three objects — policy, adaptation actions and capacity development. These three dimensions are complementary: policies create enabling conditions, actions translate policy into practice, and capacity development sustains adaptation performance over time. Collectively, they form a feedback structure that enables Indonesia to transform data into decisions, and decisions into measurable outcomes, as encouraged by the UNFCCC NAP Technical Guidelines (2025 update, Sections 83–93).

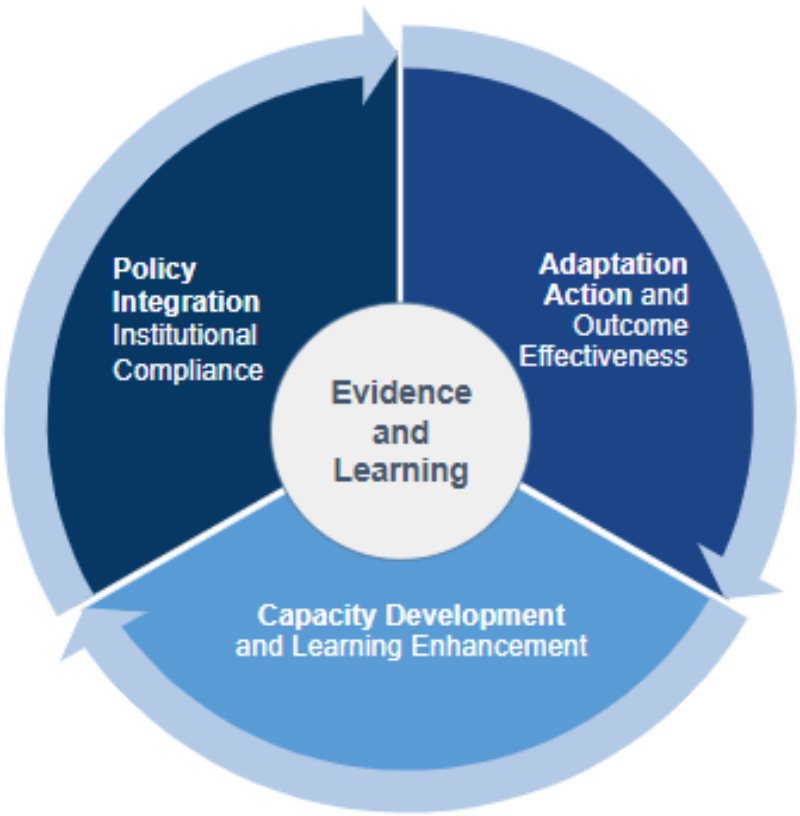


Figure 8.3 ***Core monitoring domains and feedback logic of the MEL framework***

The monitoring domains and indicative indicators applied under the MEL system are summarised in Table 8.3.

Table 8.3 Monitoring domains and indicative indicators under the MEL framework

Monitoring domain	Indicative indicators	Primary data sources / systems	Reporting frequency	Responsible institutions	Verification and validation level
1. Policy integration and institutional compliance	- Number of national and sub-national regulations integrating climate risk and adaptation measures - Alignment of sectoral strategies and RPJMN/ RPJMD with NAP targets - Existence of institutional mechanisms or working groups on adaptation - Incorporation of climate scenarios (BMKG data) into planning instruments (e.g. spatial plans, infrastructure design)	SRN-PPI policy registry; AKSARA planning database; ministry-issued decrees and regulations	Annual	KLH/BPLH with Bappenas and provincial governments	**Tier 1:** Document verification by provincial DLH **Tier 2:** Policy coherence validation by Bappenas **Tier 3:** National consolidation by KLH/BPLH
2. Adaptation actions and outcome effectiveness	- Number of adaptation programs and projects implemented in five priority sectors (food, water, energy, health, ecosystem) - Area, population, or infrastructure protected or restored (e.g. ha of mangroves rehabilitated, km of irrigation canals improved) - Percentage of adaptation actions achieving target outputs and outcomes - Level of risk reduction (flood, drought, heat, disease incidence) - Volume of finance mobilized for adaptation from public and private sources	SRN-PPI action registry; CBT system (Kemenkeu); sectoral ministry reports; disaster impact database/ DIBI (BNPB); BMKG climate-risk datasets	Annual and tri-annual consolidation	Sectoral ministries (Agriculture, Public Works, Energy, Health, Forestry) and provincial DLH; coordinated by KLH/BPLH	**Tier 1:** Data validation by sectoral focal points **Tier 2:** Tri-annual MEL review by KLH/BPLH and Bappenas **Tier 3:** Independent verification for BTR preparation
3. Capacity development and learning enhancement	- Number of technical trainings, workshops and certifications on climate adaptation - Proportion of government institutions with functional adaptation units or focal points - Inclusion of adaptation modules in civil service, university or professional curricula - Knowledge products and tools developed (e.g., guidelines, decision-support systems) - Stakeholder engagement in MEL learning reviews (gender and youth participation)	SRN-PPI capacity registry; KLH/ BPLH and Bappenas training records; ProKlim reports; university and professional association data	Annual for training; Tri-annual for learning review	KLH/BPLH and Bappenas with universities, professional associations and sub-national governments	**Tier 1:** Verification by training organisers and provincial agencies **Tier 2:** Review by KLH/ BPLH learning secretariat **Tier 3:** National evaluation during MEL Review and Learning Workshop

8.3.1 Policy Integration and Institutional Compliance

Monitoring of policy integration examines how adaptation principles are embedded in the country's regulatory and planning frameworks. Guided by Perpres 110/2025 (Article 50 and 58), MEL assesses whether climate resilience has been mainstreamed into sectoral strategies, development plans (*RPJMN* and *RPJMD*) and regional action plans for climate change adaptation. Indicators in *Annex III* of MoEF Regulation 12/2024 include the existence of legal instruments supporting adaptation, alignment between those instruments and national adaptation goals, and consistency with the Enhanced NDC. This domain therefore measures compliance — how far institutions have internalised adaptation mandates into their governance processes.

Policy monitoring is conducted through document review, regulatory mapping and consistency checks between national and sub-national plans. For example, the inclusion of climate-resilient infrastructure standards in the National Urban Development Strategy or the use of BMKG climate projections in regional spatial plans demonstrates measurable policy integration. The analytical focus is not on counting documents, but on evaluating coherence — how well planning and regulatory instruments support implementation. By embedding this dimension into MEL, Indonesia operationalises the NAP Guideline requirement that institutional integration and enabling conditions must be continuously assessed as part of the adaptation cycle.

8.3.2 Adaptation Actions and Implementation Effectiveness

The second dimension concerns the tracking of actions undertaken to implement adaptation measures across the NAP's five priority sectors — food, water, energy, health, and ecosystem (FWEHE). Derived from Article 91 letter (b) of Permen LHK 12/2024, this domain captures the physical and social outcomes of adaptation investments. Indicators quantify the outputs and outcomes of adaptation interventions: for instance, hectares of restored mangroves, length of rehabilitated irrigation canals, number of early warning systems installed, or percentage of communities benefiting from resilient health facilities. Data are recorded by executing agencies and verified progressively through provincial and sectoral authorities before being consolidated nationally in the SRN-PPI.

Action-level monitoring serves two analytical purposes. First, it measures achievement — whether implementation aligns with the quantitative and qualitative targets established in the NAP. Second, it evaluates effectiveness — whether the implemented actions demonstrably reduce vulnerability or strengthen adaptive capacity. Quantitative verification is complemented by participatory reviews such as Community-based Climate Action/*Program Kampung Iklim* (ProKlim) assessments, which provide local context and capture intangible benefits such as behavioural change or institutional coordination. The combination of quantitative and qualitative evaluation aligns with the NAP Technical Guidelines (2012, Section 92; 2025 update, Section 87), which recommend the use of

process, output and impact indicators to ensure balanced assessment.

MEL's standardised templates, detailed in *Annex III* of Permen LHK 12/2024, ensure that information on adaptation actions is comparable across regions and sectors. Each record includes activity name, implementation period, geographic location, adaptive technology used, financial source and the corresponding policy reference. This design creates traceability from field-level implementation to national reporting. Verified results become inputs for the Biennial Transparency Report (BTR), fulfilling UNFCCC Decision 18/CMA.1 (Annex Paragraph 105) on adaptation transparency.

8.3.3 Capacity Development and Learning Enhancement

The third dimension of MEL assesses the extent to which adaptation implementation builds and sustains institutional and human capacities. According to Article 91 letter (c) of Permen LHK 12/2024, monitoring and evaluation must cover *increasing the capacity of climate change adaptation resources*. This includes training, technology transfer, research collaboration and the establishment of coordination mechanisms that enhance the resilience of governance systems. Indicators encompass the number of personnel trained, coverage of training programmes, inclusion of gender and youth participation, integration of climate modules into professional certification, and formation of university or private sector partnerships for adaptive research and innovation.

Capacity level monitoring serves as the system's learning mechanism. By tracking improvements in institutional and human resources, MEL determines whether Indonesia is progressively developing the skills and systems necessary for long-term adaptation. Findings from this domain are discussed in tri-annual MEL Review and Learning Workshops, providing direct feedback to policy-makers. In this way, capacity evaluation bridges the quantitative focus of action monitoring with the qualitative insights required for adaptive management. It directly operationalises the learning principle articulated in the NAP Technical Guidelines (2025 update, Sections 88–90), which emphasises that knowledge and institutional strengthening are integral components of monitoring and evaluation.

8.3.4 Integration and Analytical Coherence

While each domain serves a distinct purpose, the strength of MEL lies in their integration. Policy monitoring ensures that adaptation has a clear regulatory foundation; action monitoring measures implementation results; and capacity monitoring assesses whether the system can sustain and improve those results. Together they create a continuous feedback loop that allows Indonesia to assess both compliance and performance. This integrated scope satisfies the mandate of Perpres 110/2025 Article 90-92, which calls for comprehensive monitoring of adaptation implementation, and reinforces the principle of

'learning by doing' embedded in the NAP Technical Guidelines.

Operationally, integration is achieved through shared indicators, harmonised reporting formats, and cross-linkages among SRN-PPI, AKSARA and CBT. These connections enable information from one domain to inform another: data on financing in CBT verify efficiency in action monitoring; policy updates recorded in AKSARA provide context for evaluating coherence; and capacity-building records help explain performance differences across sectors. This coherence transforms MEL from a fragmented monitoring tool into a national analytical system capable of supporting evidence-based decision-making.

Through this integrated scope, Indonesia's MEL is not only tracks adaptation activities, but also measures the governance capacity that sustains them. It connects results on the ground with policy and finance at the centre, ensuring that adaptation is transparent, accountable and continuously improving in accordance with national law and global standards. The linkages among data systems supporting the three MEL monitoring domains are summarised in Table 8.4.

Table 8.4 Data systems supporting each MEL domain

MEL monitoring domain	Primary national data system	Type of data / key variables	Verification level	Data custodian	Integration linkage
1. Policy integration and institutional compliance	**AKSARA** (*Analytical Knowledge System for Climate-Resilient Development Planning*) – managed by Bappenas	Policy instruments, development plans, regulatory frameworks, adaptation priorities integrated into RPJMN, RPJMD development plans, and sectoral strategies	**Tier 1:** Document validation by Bappenas directorates **Tier 2:** Cross-verification by KLH/BPLH policy unit **Tier 3:** National approval by MEL Steering Committee	Bappenas (Directorate for Environmental Affairs) in coordination with KLH/BPLH	SRN-PPI pulls regulatory metadata from AKSARA for consistency in national adaptation registry
2. Adaptation actions and outcome effectiveness	**SRN-PPI** (*National Registry System for Climate Change Control*) – managed by KLH/BPLH	Registered adaptation projects and programmes, locations, implementers, budgets, beneficiaries, outcomes, technologies, alignment with NAP and NDC	**Tier 1:** Validation by implementing agencies (ministries, provinces) **Tier 2:** Provincial verification by DLHs **Tier 3:** National consolidation by KLH/BPLH	KLH/BPLH – Directorate General of Climate Change Control	Serves as the core MEL data backbone; connected to AKSARA (planning) and CBT (finance)
	CBT (*Climate Budget Tagging System*) – managed by Kemenkeu	Public and private expenditure on adaptation, financial flows by sector and region, efficiency ratios (cost vs outcome)	**Tier 1:** Entry validation by budget units **Tier 2:** Aggregation and review by Directorate of Budgeting **Tier 3:** Alignment with NAP targets verified by KLH/BPLH–Kemenkeu joint review	Ministry of Finance – Directorate of Climate Finance and Multilateral Cooperation	CBT financial records linked to SRN-PPI project entries through MEL integration dashboard

MEL monitoring domain	Primary national data system	Type of data / key variables	Verification level	Data custodian	Integration linkage
3. Capacity development and learning enhancement	**Adaptation Platform** (Adaptation Learning Window) – managed by KLH/BPLH	Knowledge products, learning materials, training records, institutional capacity metrics, ProKlim data, MEL Learning Notes	**Tier 1:** Verification by learning organisers and DLH. **Tier 2:** Review by MEL Learning Secretariat **Tier 3:** National synthesis during tri-annual MEL Review	KLH/BPLH in collaboration with Bappenas and universities.	Adaptation Platform acts as MEL's public interface and learning platform; uploads summarised information from SRN-PPI and training registries
Cross-cutting supporting systems	**BMKG, BNPB, BIG, BPS**	– BMKG: climate, weather, seasonal projections, and early warning system – BNPB: disaster management, impact and loss data – BPS: socio-economic and population statistics – BIG: One Map data	Validation under respective institutional mandates and verified for MEL integration by KLH/BPLH Data Governance Unit.	BMKG, BNPB, BIG and BPS	Provide baseline and contextual datasets feeding into SRN-PPI indicators and MEL reports (e.g. risk trends, exposure, vulnerability)

8.4 Operational Cycle and Review Process

The operational cycle of the MEL system determines how Indonesia tracks, interprets and acts upon adaptation performance over time. It links routine data collection with periodic review and national policy revision, forming a continuous loop between implementation and decision-making. This cycle is anchored in Perpres 110/2025 (Article 90-92), which obliges systematic evaluation of adaptation, mitigation and transparency activities, and in MoEF Regulation 12/2024 (Articles 93 and 94), which require that monitoring and evaluation be undertaken at least once every year and reported through the SRN-PPI. The structure also follows the logic of iterative learning emphasised in the UNFCCC NAP Technical Guidelines (2025 update, Sections 83–93), where monitoring and evaluation are framed as processes that inform adaptive management rather than mere compliance.

Figure 8.4 ***Temporal Cycle of the MEL Implementation Framework***

8.4.1 Annual Monitoring Cycle

At the base of the cycle lies the annual monitoring process, which ensures that adaptation implementation is observed continuously and verified regularly. Local governments, sectoral agencies and implementing partners record their activities in the SRN-PPI using the formats defined in *Annex III* of Permen LHK 12/2024. These entries include quantitative data — such as physical targets achieved, financial disbursement and beneficiary coverage — and qualitative narratives describing local innovations or constraints. Provincial environment offices (DLHs) aggregate the data and conduct first-level verification, confirming completeness and internal consistency. The verified dataset is then transmitted to the relevant sectoral ministries for thematic validation.

This annual process provides an updated national picture of adaptation actions and resources. It functions as an *early warning system* for underperformance: if certain targets are consistently below expectation, corrective measures — budget adjustments, technical support or regulatory review — can be triggered within the same fiscal year. In analytical terms, the annual cycle satisfies the NAP Guideline requirement that countries establish mechanisms for 'regular stock-taking and adjustment of implementation strategies' (2025 update, Paragraph 86).

8.4.2 Tri-annual Review and Learning Cycle

Every three years, KLH/BPLH convenes a National MEL Review and Learning Workshop, co-led with Bappenas and Kemenkeu. This tri-annual cycle represents the learning pivot of MEL. Data from three consecutive annual monitoring cycles are consolidated, analysed for trends, and compared against the mid-term targets of the NAP and the Enhanced NDC. The review examines both sectoral performance and cross-sectoral enablers — finance mobilisation, policy coherence and institutional coordination.

The outcomes of the tri-annual review are twofold. First, a *National Adaptation Progress Report* (NAPR) is produced, detailing achievements, gaps and policy recommendations. Second, a *Learning Note* is issued summarising lessons and best practices to be shared through the *Adaptation Platform* for public access. By formalising this three-year learning rhythm, Indonesia converts monitoring results into policy intelligence, fulfilling the NAP Guidelines (2025 update, Section 89) directive that learning outcomes must directly inform planning revisions. It also provides an intermediate evidence base for the Biennial Transparency Report (BTR) under the Enhanced Transparency Framework. The temporal structure, main activities and outputs of the MEL operational cycle are summarised in Table 8.5.

Table 8.5 MEL operational cycle and outputs

Cycle / timeframe	Objective	Main Activities	Key outputs / deliverables	Lead institution	Supporting / participating entities	Link to national and UNFCCC reporting
Annual monitoring cycle	To ensure continuous observation and verification of adaptation actions and policy implementation	- Collection of data on adaptation actions and indicators through SRN-PPI - Validation and aggregation at provincial and sectoral levels - Compilation of annual monitoring summaries and dissemination through the *Adaptation Platform*	Annual MEL Monitoring Report and updated SRN-PPI dataset (online)	KLH/BPLH – Directorate General of Climate Change Control	Sectoral ministries, provincial DLHs, BMKG, BNPB, BPS and local governments	Feeds into *Biennial Transparency Report (BTR)* and internal adaptation dashboards
Tri-annual review and learning cycle	To analyse multi-year trends and institutional learning outcomes	- Consolidation of three annual cycles of data - Thematic analysis by sector and region - Convening of the *National MEL Review and Learning Workshop* - Development of Learning Notes and recommendations	**National Adaptation Progress Report (NAPR)** and **Learning Notes**	KLH/BPLH (as lead) with Bappenas (co-chair)	Kemenkeu, sectoral ministries, universities, CSOs, private sector, and sub-national representatives	Provides evidence base for NDC stocktake and forms core content of the next BTR
Five-year mid-term evaluation (aligned with RPJMN cycle)	To assess cumulative progress and recalibrate NAP and NDC targets within the RPJMN planning horizon	- Comprehensive evaluation of effectiveness, efficiency and sustainability of adaptation measures - Financial performance analysis using CBT data - Stakeholder consultations for strategy adjustment	**Mid-Term Evaluation Report on NAP Implementation** (synthesised by KLH/BPLH and Bappenas)	KLH/BPLH and Bappenas	Kemenkeu, Coordinating Ministries, provincial, governments nd National MEL Steering Committee	Provides evidence for RPJMN revision and Indonesia's *National Communication* to UNFCCC
Decadal Comprehensive Review and NAP Update	To evaluate long-term adaptation performance and formulate the updated National Adaptation Plan.	- Independent assessment of MEL performance, data governance and institutional capacity - Synthesis of decadal evidence on risk reduction and resilience outcomes - Preparation of the NAP Update (2035)	NAP Update and Comprehensive MEL Review Report	KLH/BPLH as National Focal Point	Bappenas, Kemenkeu, sectoral ministries, sub-national governments, academia and development partners	Constitutes Indonesia's long-term Adaptation Communication (AdCom) submission and ETF compliance report

8.4.3 Five-Year Mid-Term Evaluation

In alignment with the RPJMN planning cycle (2025–2029), MEL undertakes a five-year mid-term evaluation to assess cumulative progress and recalibrate strategic priorities. This evaluation coincides with the preparation of the next RPJMN and serves as the bridge between adaptation evidence and national development planning. Under Article 90 of Perpres 110/2025, the results form part of the *National Report on the Implementation of the NDC* submitted to the President through the Coordinating Minister. The evaluation covers three dimensions:

1. **Effectiveness** — the degree to which adaptation actions have achieved intended outcomes;
2. **Efficiency** — the ratio between financial inputs recorded in CBT and outputs verified in SRN-PPI; and
3. **Sustainability** — the institutionalisation of adaptation practices in policy and budgeting frameworks.

The mid-term evaluation provides the empirical foundation for revising NAP targets and ensuring that subsequent investments are evidence-based. It strengthens coherence between national climate policy and long-term development pathways, thereby meeting the NAP Guideline (2012 Section 84) principle that monitoring results must feed directly into strategic planning processes.

8.4.4 Decadal Comprehensive Review and NAP Update

A comprehensive review every ten years marks the closure of one full NAP cycle. This decadal assessment evaluates the overall effectiveness of adaptation governance in achieving the objectives set under the NDC 2030 target and the subsequent 2040 horizon. It is led by KLH/BPLH with participation from all line ministries, sub-national governments and non-state actors, following the transparency procedures of Presidential Regulation 110/2025 Article 91. Findings are used to prepare the NAP Update, which will serve as Indonesia's forward-looking adaptation communication to the UNFCCC and inform the next generation of national policies.

The decadal review synthesises quantitative indicators — such as cumulative risk reduction and resilience improvements — with qualitative assessments of policy effectiveness, social inclusion and technological innovation. It not only reports achievements but also identifies systemic constraints in data governance, finance mobilisation or institutional capacity. This process satisfies the iterative-learning expectation of the NAP Guidelines (2025 update, Section 92) and demonstrates Indonesia's compliance with the Enhanced Transparency Framework requirement for long-term adaptation tracking.

8.4.5 Cross-Cutting Quality Assurance and Feedback

Throughout all temporal layers, quality assurance is maintained through multi-level validation and feedback loops. Each dataset entering SRN-PPI is checked for completeness and accuracy at the local and sectoral levels, validated by KLH/BPLH and cross-referenced with AKSARA and CBT. Independent reviewers — universities, research institutes, and professional associations — are engaged periodically to enhance methodological robustness. Feedback from these reviews informs subsequent data-collection guidelines and indicator adjustments, ensuring that MEL remains scientifically credible and administratively feasible.

The feedback mechanism also supports accountability to stakeholders. Summary results are disseminated through Adaptation Platform and presented in public forums, enabling civil society and private-sector partners to scrutinise progress. This open-data practice operationalises the transparency principles of Perpres 110/2025 Article 75-86 and creates a virtuous cycle of evidence, learning, and trust between government and society.

8.5 Transparency, Reporting, and Policy Feedback

Transparency is the defining feature that transforms Indonesia's MEL system from an internal management tool into an instrument of accountability, trust and continuous policy improvement. It ensures that the progress of adaptation actions can be observed, verified and communicated both domestically and internationally in accordance with the Enhanced Transparency Framework (ETF) under Article 13 of the Paris Agreement. The procedures for transparency and reporting are codified in Perpres 110/205 (Articles 75-86) and operationalised through MoEF Regulation 12/2024 (Articles 93–94). Together they establish a system that guarantees information credibility, accessibility and usefulness for decision-making. The transparency mechanisms and main reporting products established under the MEL system are summarised in Table 8.6.

Table 8.6 Transparency mechanisms and reporting products under the MEL framework

Reporting product / mechanism	Purpose and content	Frequency	Lead institution	Participating / supporting entities	Primary target audience	Link to UNFCCC reporting vehicle
1. Annual MEL Monitoring Report	Compiles verified data from SRN-PPI on adaptation policies, actions and capacity building achievements; summarises progress in the five priority sectors (FWEHE)	Annual	KLH/BPLH – Directorate General of Climate Change Control	Sectoral ministries, provincial DLHs, BMKG, BNPB, BPS	National stakeholders, provincial governments and public via the *Adaptation Platform*	Forms part of domestic transparency documentation and data input for the Biennial Transparency Report (BTR)

Reporting product / mechanism	Purpose and content	Frequency	Lead institution	Participating / supporting entities	Primary target audience	Link to UNFCCC reporting vehicle
2. National Adaptation Progress Report (NAPR)	Synthesises data from three consecutive monitoring cycles; analyses performance trends, identifies barriers, and formulates lessons learned	Every 3 years	KLH/BPLH (lead) with Bappenas (co-lead)	Kemenkeu, line ministries, academia, CSOs and private sector	National policy-makers, MEL Steering Committee, and UNFCCC focal institutions	Serves as an intermediate input to the BTR and supports Adaptation Communication (AdCom) updates
3. Learning Notes and Knowledge products	Capture key insights, innovative practices, and policy recommendations derived from MEL reviews and learning workshops	Every 3 years (following MEL Review)	KLH/BPLH Learning Secretariat	Universities, research institutions and regional governments	Adaptation practitioners, donors and learning networks (national and international)	Contributes to AdCom narrative and ETF 'good practices' sections
4. Mid-Term Evaluation Report on NAP Implementation	Evaluates cumulative progress, efficiency and sustainability of adaptation actions within the RPJMN period (5 years)	Every 5 years	KLH/BPLH and Bappenas	Kemenkeu, coordinating ministries, and MEL Steering Committee	President and National Development Council, international partners	Supports Indonesia's National Communication (NC) and NDC progress update
5. Comprehensive MEL Review and NAP Update	Provides long-term synthesis of adaptation performance, institutional learning, and emerging priorities; informs the next NAP cycle	Every 10 years	KLH/BPLH as National Focal Point to UNFCCC	Bappenas, Kemenkeu, sectoral ministries, sub-national governments, development partners	National and international audiences; UNFCCC Secretariat	Forms Indonesia's Adaptation Communication (AdCom) and ETF compliance report under Article 13 of the Paris Agreement
6. Adaptation Platform (Adaptation Learning Window)	Public online platform publishing open-access MEL data, adaptation maps, reports and learning resources	Continuously updated	KLH/BPLH	Sectoral ministries, DLH, universities, CSOs	General public, researchers, media and private sector	Enhances public transparency and stakeholder engagement; complements ETF accessibility principles

8.5.1 Legal and Institutional Basis for Transparency

Articles 75-76 of Perpres 110/2025 require that all mitigation, adaptation and carbon value activities be implemented in a manner that is accurate, consistent, transparent, sustainable and accountable. They mandate that measurement, reporting and verification (MRV) be conducted through (1) a national registry (SRN-PPI), (2) a measurement protocol that records baselines and progress, and (3) a certification process for data integrity. Articles 66 through 68 detail the reporting and validation steps, requiring that all data on adaptation actions include information on implementation status, funding sources, technology use and beneficiaries. Article 93 of Permen LHK 12/2024 reinforces this obligation by requiring annual submission of monitoring and evaluation results through SRN-PPI and public reporting of aggregated findings.

Institutionally, transparency functions through a multi-tier reporting chain. Local governments and executing agencies upload verified data into SRN-PPI; provincial authorities conduct technical screening for consistency; sectoral ministries validate the data against national targets; and KLH/BPLH performs final quality control and publishes the results. This sequence ensures that each level of government is accountable for data accuracy while the national level guarantees coherence and comparability across sectors. Such an approach complies with the ETF principles of transparency, accuracy, completeness and consistency as outlined in Decision 18/CMA.1 (Annex Paragraph 92).

8.5.2 Mechanisms for Data Verification and Disclosure

Verification within MEL operates through a two-layer process: technical validation and public disclosure. Technical validation is conducted by sectoral ministries and KLH/BPLH to confirm that the methodologies used for indicator calculation are scientifically sound and consistent with national standards. Cross-checking between SRN-PPI, AKSARA and CBT ensures that reported outputs and financial records match. When necessary, independent reviewers from universities or professional associations are commissioned to audit specific datasets, enhancing credibility and neutrality. This arrangement fulfills the NAP Guidelines (2025 update, Paragraph 94), which encourage countries to use independent review to strengthen confidence in reported information.

The second layer of transparency is public disclosure. After verification, aggregated results are published through The Adaptation Platform, the national online platform for climate adaptation information. The portal presents summarised data on sectoral performance, budget utilisation and geographical distribution of adaptation actions. It also hosts visual dashboards linking MEL indicators with national development goals and the Sustainable Development Goals (SDGs). By making this information publicly accessible, Indonesia translates domestic accountability into international transparency. It also stimulates horizontal learning among regions and institutions, as local governments can benchmark their progress against national averages.

8.5.3 Reporting Architecture and International Linkages

The reporting architecture of MEL is built around a single data flow that supports multiple outputs. At the national level, KLH/BPLH consolidates sectoral and regional results into the National Adaptation Progress Report (NAPR), produced every three years in conjunction with the MEL Review and Learning Workshop. This report forms the basis for the Biennial Transparency Reports (BTRs) submitted to the UNFCCC Secretariat. Information on adaptation policies, actions and support needs is also integrated into the

Adaptation Communication (AdCom), ensuring continuity between domestic monitoring and international reporting. The use of one data source (SRN-PPI) for multiple reporting obligations avoids duplication and minimises administrative burden, fulfilling the NAP Guidelines (2025 update, Paragraph 96) recommendation to align national and global reporting requirements.

The national reporting cycle corresponds to the temporal structure of MEL described in Section 8.4: annual monitoring feeds into the tri-annual review; the five-year evaluation supports the mid-cycle assessment of the RPJMN; and the decadal comprehensive review provides the foundation for the next NAP Update. This sequencing creates a predictable reporting calendar that ensures data continuity and policy relevance. Each reporting product is accompanied by summary indicators that track progress in the five priority sectors and cross-cutting enablers such as finance, technology and capacity. By maintaining consistent indicators across cycles, MEL ensures that trends can be quantitatively evaluated over time and linked to both national targets and UNFCCC commitments.

8.5.4 Feedback into Policy and Budget Processes

Transparency within MEL is not an end in itself; it is designed to improve policy and budgetary decisions. Findings from monitoring and evaluation are integrated into the AKSARA and CBT systems so that lessons from implementation translate into revised planning targets and financial allocations. For example, if data from SRN-PPI show that water-sector resilience investments yield higher risk reduction per unit of expenditure than other sectors, Bappenas and Kemenkeu can use that evidence to adjust future budget priorities. This feedback mechanism ensures that transparency results in tangible governance improvements, meeting the NAP Guidelines (2025 update, Section 97) principle that information generated through MEL should inform decision-making and policy refinement.

Feedback also flows through institutional learning. The tri-annual MEL Review and Learning Workshop serves as a platform for cross-sector dialogue where results are analysed, challenges identified, and recommendations developed. Outputs from these workshops are recorded as 'Learning Notes' and shared through the Adaptation Platform. At the provincial level, similar forums enable horizontal learning among local governments, promoting replication of successful approaches. By embedding learning into transparency, MEL ensures that reporting does not end with data submission but initiates a cycle of reflection and improvement.

8.5.5 Public Engagement and Accountability

A distinctive feature of Indonesia's MEL framework is its emphasis on public participation as a core element of transparency and accountability. Civil society organisations, research institutions and private-sector actors are actively invited to review and comment on published datasets through open consultations. This inclusive approach not only strengthens social trust, but also promotes collective responsibility for adaptation outcomes, reflecting the ETF's principle that transparency should be participatory and equitable. Moreover, this practice aligns with the NAP Technical Guidelines (2025 update, Section 101), which emphasise stakeholder engagement and open data as key enablers of adaptive learning. By opening national adaptation data to public scrutiny, Indonesia reinforces that transparency is not merely a bureaucratic requirement, but a fundamental governance principle that underpins credibility and shared ownership of climate action.

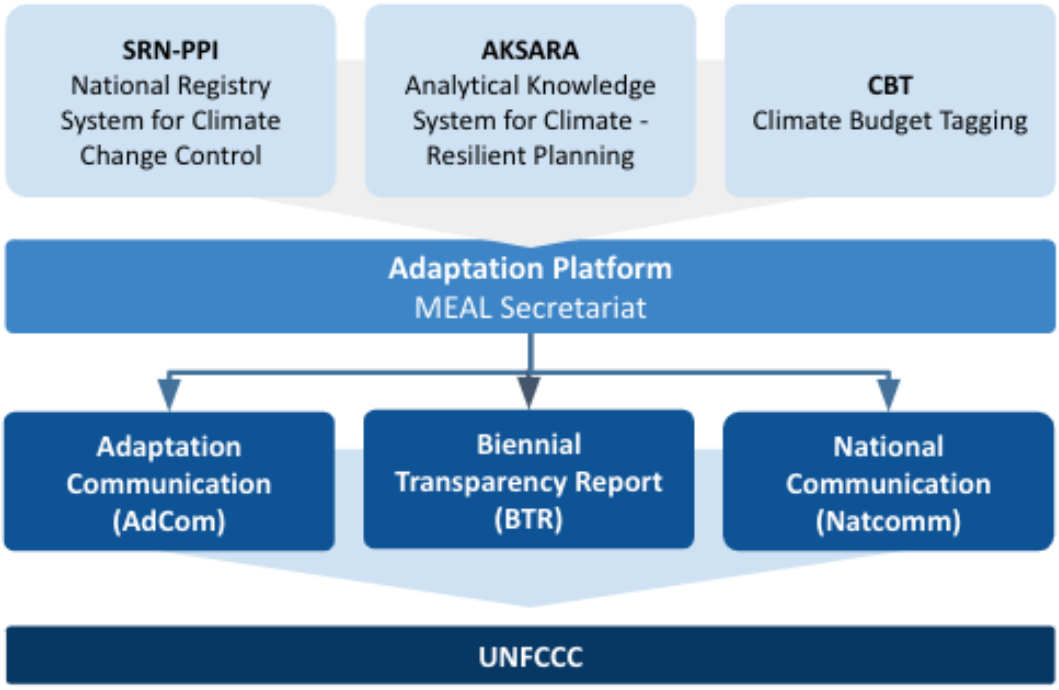


Figure 8.5 ***Transparency and reporting architecture of the MEL framework***

Building upon this participatory foundation, Indonesia's reporting flow to the UNFCCC (illustrated in Figure 8.5) ensures that national transparency efforts are systematically connected to global accountability processes. The reporting begins with three primary national systems: SRN-PPI, the national registry managed by KLH/BPLH; AKSARA, the analytical platform of Bappenas for climate-resilient planning and monitoring; and CBT, the climate budget tagging system coordinated with Kemenkeu. These reporting streams are integrated through the Adaptation Platform, which serves as the MEL Secretariat. The Secretariat consolidates information and produces official outputs — namely the Adaptation Communication (AdCom), the Biennial Transparency Report (BTR), and the

National Adaptation Plan (NAP) Report — that collectively document adaptation processes, portfolios, results and lessons learned. Finally, these reports are submitted to the UNFCCC as part of Indonesia's international accountability mechanism, completing a transparent learning loop that informs evidence-based improvements in national adaptation planning and implementation.

8.6 Policy Feedback and Continuous Improvement

The ultimate purpose of the MEL system is to ensure that adaptation in Indonesia functions as a living, evolving process — one that learns from evidence, refines its methods, and strengthens institutional performance over time. MEL provides not merely a diagnostic mechanism, but a governance cycle through which lessons from implementation directly inform policy formulation, planning and budgeting. In this sense, it transforms monitoring results into actionable intelligence that sustains adaptive management. To reinforce this function, the NAP's Monitoring and Evaluation framework will establish a structured feedback loop mechanism that follows the reporting and monitoring procedures defined under the MoEF Regulation 12/2024. This mechanism ensures that inputs from local implementation — covering adaptation action progress, performance indicators and lessons learned — feed directly into periodic reviews and updates of the national plan, thereby enabling continuous improvement and coherence across governance levels. This operational logic is fully consistent with Perpres 110/2025, which mandates that evaluation outcomes feed into policy and oversight, and with MoEF Regulation No. 12/2024 (Articles 91 and 93), which requires the continuous integration of adaptation monitoring into institutional decision-making.

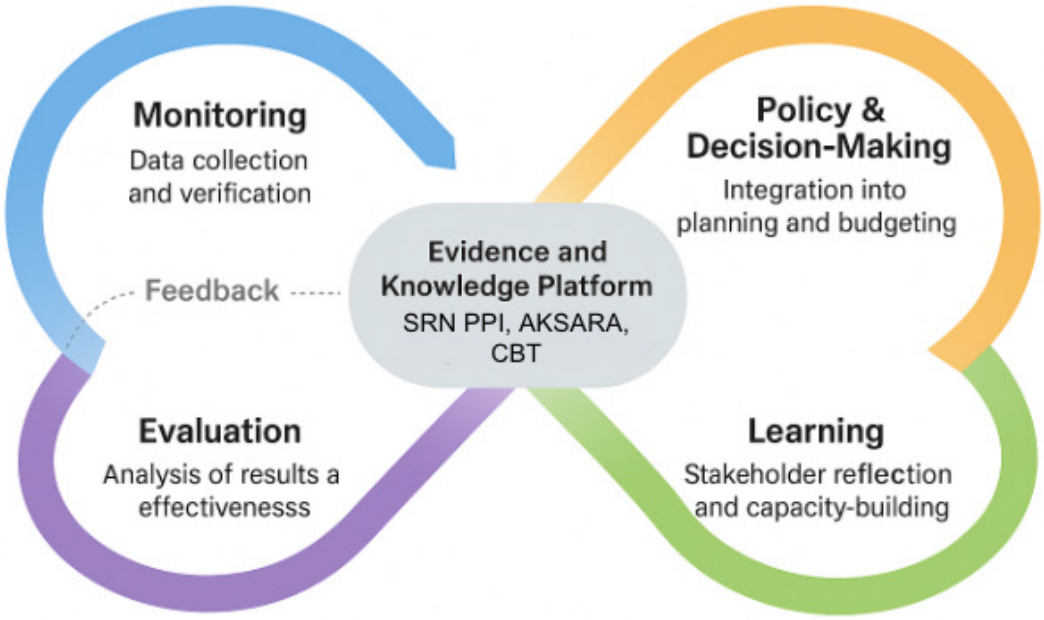


Figure 8.6 ***MEL feedback loop for continuous improvement***

8.6.1 Translating Evaluation into Policy Action

The first pathway of feedback occurs through policy adjustment. Data and analysis generated from MEL are used by ministries and regional governments to review existing regulations, guidelines and strategies. KLH/BPLH synthesises evidence from the *National Adaptation Progress Report* and the *Biennial Transparency Report* into policy briefs and recommendations circulated to other ministries through the National Adaptation Coordination Forum. This process allows sectoral policies — such as water resource management, agricultural resilience or energy diversification — to be refined in line with the latest evidence on vulnerability and effectiveness.

At the sub-national level, provincial and regency/municipal governments use MEL findings to revise their regional action plans for climate change adaptation (RAD-API) and related development plans. This decentralised feedback ensures that local actions remain aligned with national goals while retaining contextual flexibility. In line with the NAP Technical Guidelines (2025 update, Sections 98–101), feedback loops are designed to link technical evaluation to decision-making, ensuring that monitoring outcomes are not archived, but translated into governance improvements.

8.6.2 Integration with Planning and Budgeting Systems

The second feedback pathway lies in Indonesia's planning and financial architecture. The AKSARA system managed by Bappenas and the Climate Budget Tagging (CBT) system managed by Kemenkeu are integral components of MEL. Evaluation results from SRN-PPI are transmitted to these platforms to inform annual planning and budgeting cycles. For example, if MEL identifies that coastal protection programmes underperform relative to investment levels, Bappenas can adjust the next RPJMN targets, while Kemenkeu can modify funding allocations or incentive mechanisms.

This data-driven approach institutionalises *adaptive planning*: plans and budgets evolve in response to verified evidence rather than static assumptions. It also enables financial accountability, as every rupiah invested in adaptation can be traced through CBT to the corresponding verified action in SRN-PPI. The integration of MEL with these systems demonstrates Indonesia's commitment to the NAP Guideline (2025 update, Section 97), which urges countries to link monitoring results to the resource allocation process. It also operationalises Perpres 110/2025 Article 90-91, which requires that monitoring and evaluation results form part of the national report submitted to the President — ensuring that adaptation performance influences high-level policy direction. The feedback mechanisms through which MEL results inform national policies and institutional actions are summarised in Table 8.7.

Table 8.7 Policy feedback mechanisms and responsible entities under the MEL framework

Feedback mechanism	Trigger source (MEL cycle)	Lead institution	Supporting / collaborating agencies	Decision or output instrument	Purpose and expected outcome
1. Policy adjustment and regulatory update	Tri-annual MEL Review and Learning Cycle	KLH/BPLH – Directorate General of Climate Change Control	Bappenas, sectoral ministries, coordinating ministries and sub-national governments	Policy briefs, ministerial circulars, revisions to sectoral regulations (e.g. infrastructure, agriculture, energy)	Ensure national and sectoral policies remain aligned with updated evidence on vulnerability and adaptation effectiveness
2. Integration into national and regional planning (RPJMN/RPJMD)	Five-Year Mid-Term Evaluation (aligned with RPJMN)	Bappenas – Directorate of Environmental Affairs and Directorate of Development Planning	KLH/BPLH, Ministry of Finance, sectoral ministries, and provincial Bappeda	Updated NAP targets and adaptation priorities in RPJMN/RPJMD documents	Embed MEL results into medium-term development planning and strengthen resilience mainstreaming in government programmes
3. Budget reallocation and financial prioritisation	Annual Monitoring and Tri-annual Review cycles	Kemenkeu	KLH/BPLH, Bappenas, provincial finance offices	Adjusted Climate Budget Tagging (CBT) allocations, revised fiscal incentives and funding priorities	Align financial flows with verified adaptation outcomes; enhance efficiency and accountability in adaptation finance
4. Institutional strengthening and capacity building	Continuous learning across all MEL cycles	KLH/BPLH and Bappenas jointly	Universities, research institutes, training centres, professional associations	National and provincial training programmes; updated technical guidelines and MEL manuals	Improve institutional capacity and technical competency for sustained MEL implementation and adaptive governance
5. Indicator and methodology refinement	Decadal Comprehensive MEL Review	KLH/BPLH – Technical Working Group on Adaptation Indicators	BMKG (climate data), BNPB (disaster data), BPS (socio-economic data), and sectoral experts	Revised indicator frameworks, updated *Annex III* of Permen LHK 12/2024, technical circulars	Maintain methodological relevance and scientific credibility of MEL indicators and data standards
6. Stakeholder learning and public communication	Tri-annual Review and Annual Monitoring Summaries	KLH/BPLH Learning Secretariat	CSOs, private sector, academia, media, sub-national governments	Learning Notes, public reports and updates in *Adaptation Platform*	Strengthen transparency, multi-stakeholder participation and knowledge sharing for collective adaptation learning
7. Strategic coordination for NAP update	Decadal Comprehensive Review	KLH/BPLH as National Focal Point to UNFCCC	Bappenas, Kemenkeu, National MEL Steering Committee and development partners	Draft of the *National Adaptation Plan (NAP) Update*, submission to the President and UNFCCC	Ensure long-term strategic adaptation direction, integrating MEL results into future national and international commitments

Source: Compiled from *Perpres 110/2025 (Article 75-92); Permen LHK 12/2024 (Articles 90–94); and UNFCCC NAP Technical Guidelines (2025 update, Sections 97–104)*

8.6.3 Institutional Learning and Capacity Strengthening

Beyond policy and budgeting, MEL fosters continuous improvement through institutional learning. The tri-annual MEL Review and Learning Workshop, coordinated by KLH/BPLH in partnership with Bappenas, Kemenkeu and sectoral ministries, serves as a national platform for reflection. It brings together government agencies, academic institutions, private sector representatives and civil society organisations to analyse results, discuss challenges, and co-design solutions. These discussions often result in new technical guidelines, cross-sectoral partnerships or pilot innovations. For example, evidence of successful integrated watershed management in one province may lead to the formulation of a national model adopted elsewhere.

Lessons derived from the workshops are compiled as 'Learning Notes,' shared through the Adaptation Platform, and circulated among regional governments and development partners. These materials enable continuous professional development and knowledge dissemination across the adaptation community. The process institutionalises the *learning function* described in the NAP Technical Guidelines (2025 update, Section 89), ensuring that evaluation informs not only strategic choices, but also the capacities of the institutions implementing them.

8.6.4 Updating Indicators and Methodological Standards

Continuous improvement also depends on methodological renewal. As climate science advances and socio-economic conditions change, MEL's indicators and data protocols require periodic review. KLH/BPLH leads this process through a dedicated *Technical Working Group on Adaptation Indicators*, supported by BMKG, BPS and relevant sectoral experts. The working group assesses the relevance, accuracy and usability of existing indicators and proposes updates for approval by the National MEL Steering Committee. This practice ensures that the monitoring framework remains scientifically credible and responsive to emerging needs.

For instance, the introduction of satellite-based land subsidence monitoring or the incorporation of ecosystem-based adaptation metrics can significantly enhance the precision of outcome measurement. Revisions to indicators are formally integrated into *Annex III* of Permen LHK 12/2024 through ministerial circulars, guaranteeing legal continuity while allowing flexibility. This iterative calibration exemplifies the adaptive approach envisioned in the UNFCCC Enhanced Transparency Framework — where countries progressively refine their monitoring systems to improve transparency and comparability over time.

8.6.5 Multi-Stakeholder Engagement and Accountability

MEL's feedback system is participatory by design. Beyond government institutions, it engages universities, professional associations, community-based organisations and private enterprises in both evaluation and policy refinement processes. Stakeholder engagement is pursued through thematic dialogues and regional coordination meetings, ensuring that perspectives from different sectors and regions inform national adaptation priorities. This approach echoes the inclusiveness principle of the NAP Technical Guidelines (2025 update, Sections 101–104) and enhances public trust in reported information.

The participation of external stakeholders serves two purposes: it broadens the evidence base and strengthens social accountability. When non-government actors can observe and verify adaptation progress, data credibility increases, and political commitment to adaptation is reinforced. This openness ensures that the MEL framework remains a collaborative national enterprise rather than a technocratic procedure.

8.6.6 Driving Systemic Transformation

The cumulative effect of these feedback mechanisms is systemic transformation. By continuously connecting evidence with policy, finance and capacity, MEL redefines adaptation as a process of governance evolution rather than a fixed plan. Each monitoring cycle generates data; each evaluation produces lessons; and each lesson triggers policy refinement. Through this recursive process, Indonesia achieves the 'learning state' envisioned in both the NAP Guidelines and the Paris Agreement — where progress is measured not only by outcomes achieved, but by the ability to improve continuously.

MEL's feedback system thus completes the adaptation governance loop. It ensures that monitoring leads to evaluation, evaluation leads to learning, and learning leads to better adaptation outcomes. The system's strength lies in its institutionalisation: anchored in law, integrated with planning and finance, and sustained through inclusive participation. In this way, MEL enables Indonesia to fulfil its dual mandate—domestic accountability and global transparency — while advancing a culture of continuous improvement that makes climate adaptation a permanent and adaptive feature of national development. The indicative timeline for MEL implementation during the 2026–2035 period is presented in Table 8.8

Terasering in Magelang © Fitri, MoE/EPA, 2025

Table 8.8 Indicative timeline for MEL implementation (2026–2035)

Year / period	Main MEL activity	Cycle type	Key deliverables / outputs	Lead institution	Supporting entities	Notes / linkages
2026	Establishment of MEL governance architecture; updating indicators and SRN-PPI integration with AKSARA and CBT systems; initial training for sub-national focal points	Set-up phase	MEL operational guidelines, baseline, dataset, institutional readiness assessment	KLH/BPLH	Bappenas, Kemenkeu, provincial DLHs, BMKG, BNPB, BPS	Foundation year for MEL roll-out; aligns with first year of NAP operationalisation
2027	First full-year data collection and validation through SRN-PPI; preparation of national summary dashboard	Annual monitoring	Annual MEL Monitoring Report #1, public disclosure on Adaptation Platform	KLH/BPLH	Sectoral ministries, provincial DLHs	Establishes baseline for trend analysis
2028	Tri-annual MEL Review #1; first National Adaptation Progress Report (NAPR); issuance of Learning Notes	Tri-annual Review	NAPR 2028, Learning Notes Vol. 1	KLH/BPLH and Bappenas	Kemenkeu, CSOs, academia	Inputs to Biennial Transparency Report (BTR #1)
2029	Annual monitoring and data validation; integration of MEL findings into RPJMN mid-term review process	Annual / planning alignment	Annual MEL Monitoring Report #4; adaptation inputs to RPJMN review	Bappenas and KLH/BPLH	SekDa, line ministries	Ensures MEL–development coherence
2030	Five-Year Mid-Term Evaluation #1 of NAP; update of indicator methodologies	Mid-term evaluation	Mid-Term Evaluation Report; revised indicator framework	KLH/BPLH and Bappenas	Kemenkeu, MEL Steering Committee	Provides evidence for Indonesia's National Communication and NDC progress report
2031	Annual monitoring; dissemination of updated MEL guidance to provincial governments	Annual monitoring	MEL Monitoring Report #6, provincial capacity reports	KLH/BPLH	Provincial DLHs and Bappedas	Prepares for next tri-annual review
2032	Tri-annual MEL Review #2; National Adaptation Progress Report 2032	Tri-annual review	NAPR 2032; Learning Notes Vol. 2, synthesis for BTR #2	KLH/BPLH and Bappenas	Kemenkeu, universities, CSOs	Consolidates mid-term lessons for policy realignment
2033	Annual monitoring; assessment of policy and financial alignment through AKSARA–CBT linkage	Annual monitoring	MEL Report #8; policy-finance coherence analysis	KLH/ BPLH and Kemenkeu	Sectoral ministries, provincial finance offices	Feeds into preparation for comprehensive review

Year / period	Main MEL activity	Cycle type	Key deliverables / outputs	Lead institution	Supporting entities	Notes / linkages
2034	Preparatory work for decadal comprehensive review; stakeholder consultations and data synthesis	Preparation phase	Draft Comprehensive MEL Review; consultation briefs	KLH/BPLH (Secretariat)	Bappenas, Kemenkeu, MEL Steering Committee	Sets foundation for NAP Update 2035
2035	Decadal Comprehensive Review and formulation of the updated National Adaptation Plan (NAP Update)	Decadal review / update	Comprehensive MEL Review Report (2026–2035); NAP Update 2035; ETF submission package (AdCom 2035)	KLH/BPLH (National Focal Point to UNFCCC)	Bappenas, Kemenkeu, provincial governments, international partners	Marks completion of first full MEL cycle and transition to next NAP period (2036–2045)

Sea's Harvest © UNDP Indonesia, 2025

Moli'i Sahatu, freshwater springs from lithologic fractures within a saline coastal zone © Ika Suratno, GIZ, 2025

BIBLIOGRAPHY

Aditiya, A., & Ito, T. (2023). Present-day land subsidence over Semarang revealed by time series InSAR new small baseline subset technique. *International Journal of Applied Earth Observation and Geoinformation*, *125*(August), 103579. https://doi.org/10.1016/j.jag.2023.103579

Amelework, A. B., Bairu, M. W., Maema, O., Venter, S. L., & Laing, M. (2021). Adoption and promotion of resilient crops for climate risk mitigation and import substitution: A case analysis of cassava for South African agriculture. *Sustainable Food Systems*, *5*. https://doi.org/10.3389/fsufs.2021.617783

Ampou, E. E., Johan, O., Menkes, C. E., Niño, F., Birol, F., Ouillon, S., & Andrefouet, S. (2017). Coral mortality induced by the 2015–2016 El-Niño in Indonesia: The effect of rapid sea level fall. *Biogeosciences*, *14*, 817–826. https://doi.org/10.5194/bg-14-817-2017

Andari, L., Sugianto, D. N., Wirasatriya, A., & Ginanjar, S. (2023). Identification of sea level rise and land subsidence based on Sentinel 1 data in the coastal city of Pekalongan, Central Java, Indonesia. *Jurnal Kelautan Tropis*, *26*(2), 329–339. https://doi.org/https://doi.org/10.14710/jkt.v26i2.18324

Ashillah, A. H., Zakianis, Kusnoputranto, H., Fitratunnisa, E. P., Sauzia, S., Lestari, F., Shaw, R., & Adiwibowo, A. (2025). Linking urban sustainability and water quality: Spatial analysis of topographic, sociodemographic, and flood-related factors affecting well water in Jakarta (2017–2019). *Sustainability*, *17*(8). https://doi.org/https://doi.org/10.3390/su17083373

Bappenas. (2018). *Kaji Ulang RAN API: Kajian Basis Ilmiah Proyeksi Iklim Laut [RAN API Review: A Scientific Basis for Marine Climate Projections]*.

Bappenas. (2021). *Ringkasan Eksekutif Kebijakan Pembangunan Berketahanan Iklim 2020 - 2045 [Executive Summary of Climate Resilience Development Policy 2020 - 2040]* (S. Pratiwi & E. T. Utomo (eds.)). Badan Perencanaan Pembangunan Nasional.

Bappenas. (2022). *Strategi Nasional Pengelolaan Lahan Basah: Ekosistem Gambut Dan Mangrove [National Wetland Management Strategy: Peat and Mangrove Ecosystems]* (Medrilzam, N. H. Rahayu, & S. Yanti (eds.)). Badan Perencanaan Pembangunan Nasional.

Bappenas. (2025a). *Indonesian Biodiversity Strategy and Action Plan (IBSAP) 2025-2045*.

Bappenas. (2025b). *Rencana Pembangunan Jangka Menengah Nasional Tahun 2025 – 2029 [National Medium-Term Development Plan 2025 – 2029]*.

Bappenas. (2025c). *Rencana Pembangunan Jangka Panjang Nasional Tahun 2025 – 2045 [National Long-Term Development Plan 2025 – 2045]*.

Batubara, B., Kooy, M., & Zwarteveen, M. (2023). Politicising land subsidence in Jakarta: How land subsidence is the outcome of uneven sociospatial and socionatural

processes of capitalist urbanization. *Geoforum*, *139*. https://doi.org/https://doi.org/10.1016/j.geoforum.2023.103689

Beliyana, E., Ningsih, N. S., Gunawan, S. R., & Tarya, A. (2023). Characteristics of marine heatwaves in the Indonesian waters during the PDO, ENSO, and IOD phases and their relationships to net surface heat flux. *Atmosphere*, *14*. https://doi.org/https://doi.org/10.3390/atmos14061035

Bezner Kerr, R., Hasegawa, T., Lasco, R., Bhatt, I. D., Deryng, D., Farrell, A., Gurney-Smith, H., Ju, H., Lluch-Cota, S., Meza, F., Nelson, G., Neufeldt, H., & Thornton, P. (2022). Food, Fibre, and Other Ecosystem Products. In H.-O. Pörtner, D. C. Roberts, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Loschke, V. Moller, A. Okem, & B. Rama (Eds.), *Climate Change 2022: Impacts, Adaptation and Vulnerability* (pp. 713–906). Cambridge University Press. https://doi.org/10.1017/9781009325844.007

Birkmann, J., Liwenga, E., Pandey, R., Boyd, E., Djalante, R., Gemenne, F., Filho, W. leal, Pinho, P. F., Stringer, L., & Wrathall, D. (2022). Poverty, Livelihoods and Sustainable Development. In H. O. Portner, D. C. Roberts, M. Tignor, E. S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Loschke, V. Moller, A. Okem, & B. Rama (Eds.), *Climate Change 2022: Impacts, Adaptation and Vulnerability* (pp. 1171–1274). Cambridge University Press. https://doi.org/10.1017/9781009325844.010

BMKG. (2019). Peta Rata-Rata Curah Hujan Periode 1991-2020. In *Sustainability (Switzerland)* (Vol. 11, Issue 1). http://scioteca.caf.com/bitstream/handle/123456789/1091/RED2017-Eng-8ene.pdf?sequence=12&isAllowed=y%0Ahttp://dx.doi.org/10.1016/j.regsciurbeco.2008.06.005%0Ahttps://www.researchgate.net/publication/305320484_SISTEM_PEMBETUNGAN_TERPUSAT_STRATEGI_MELESTARI

BMKG. (2022). *Pemutakhiran Zona Musim Indonesia Periode 1991-2020 [Update of Indonesian Seasonal Zones for the Period 1991-2020]* (R. H. Damayanti, M. Denata, A. Yuswantoro, N. Wahyuni, M. A. Isra, F. Nurrahmanita, Y. A. Kristomo, R. Rahmat, D. Ariefianty, D. A. Kartika, H. Nurjannah, M. Rosmiati, S. Romadhon, & S. Pratiwi (eds.)). Badan Meteorologi Klimatologi dan Geofisika.

BNPB. (2018a). *Rencana Induk Penanggulangan Bencana 2015 - 2045 [Disaster Management Master Plan 2015 - 2045]* (R. Jati (ed.)). Pusat Data, Informasi dan Hubungan Masyarakat BNPB.

BNPB. (2018b). *Rencana Induk Penanggulangan Bencana 2015 – 2045 [Disaster Management Master Plan 2015 – 2045]*.

BNPB. (2021). *Covid-19 dan Bencana Alam di Indonesia [Covid-19 and Natural Disasters in Indonesia]* (R. Jati, T. Harjito, F. Irawan, & A. C. Utomo (eds.)). Pusat Data Informasi dan Komunikasi Kebencanaan.

BNPB. (2023). *Risiko Bencana Indonesia (RBI) [Disaster Risk in Indonesia (RBI)]* (R. Yunus (ed.)). Pusat Data Informasi dan Komunikasi Kebencanaan.

BNPB. (2025). *Data Bencana Indonesia 2024 Volume 3 [Indonesian Disaster Data 2024 Volume 3]* (A. Muhari, T. Harjito, F. Irawan, & A. C. Utomo (eds.)). Pusat Data Informasi dan Komunikasi Kebencanaan.

Bott, L.-M., Schone, T., Illigner, J., Haghighi, M. H., Gisevius, K., & Braun, B. (2021). Land subsidence in Jakarta and Semarang Bay – The relationship between physical processes, risk perception, and household adaptation. *Ocean & Coastal Management*, *211*. https://doi.org/https://doi.org/10.1016/j.ocecoaman.2021.105775

BPN. (2023). *Indeks Ketahanan Pangan Tahun 2023 [Food Resilience Index 2023]*. Badan Pangan Nasional.

BPS. (2024a). *Analisis Produktivitas Jagung Dan Kedelai Di Indonesia 2023 [Analysis of Corn and Soybean Productivity in Indonesia 2023]* (W. P. Buana, H. Ferdinan, S. Suryatiningsih, Suwarti, R. Gunawan, N. Rahmadhani, & I. Wirawati (eds.)). Badan Pusat Statistik.

BPS. (2024b). *Keadaan Ketenagakerjaan Indonesia Agustus 2024 [Indonesia's Employment Situation in August 2024]*.

BPS. (2024c). *Statistik Sumber Daya Laut dan Pesisir 2024: Pengelolaan Sumber Daya Laut untuk Pembangunan Berkelanjutan dan Kesejahteraan Masyarakat di Wilayah Pantai [Marine and Coastal Resources Statistics 2024: Marine Resource Management for Sustainable Development* (D. Aryanti (ed.)). Badan Pusat Statistik.

BPS. (2025a). *Profil Kemiskinan di Indonesia Maret 2025 [Poverty Profile in Indonesia March 2025]*.

BPS. (2025b). *SAKERNAS Februari 2025*. Badan Pusat Statistik.

BPS. (2025c). *Statistical Yearbook of Indonesia 2025 Volume 53*. Badan Pusat Statistik.

BPS, & BRIN. (2024). *Luas Panen dan Produksi Padi di Indonesia 2023 [Harvested Area and Rice Production in Indonesia 2023]* (W. P. Buana, S. Suryaningsih, R. Poerwaningsih, & S. Haryanto (eds.)). Badan Pusat Statistik dan Badan Riset dan Inovasi Nasional.

BPS, & BRIN. (2025). *Luas Panen dan Produksi Padi di Indonesia 2024 [Paddy Harvest and Production Area in Indonesia 2024]* (W. P. Buana, S. Suryatiningsih, U. Widiayontoro, H. Ferdinan, & R. Poerwaningsih (eds.)). Badan Pusat Statistik dan Badan Riset dan Inovasi Nasional.

Brown, I. (2025). Risk tolerance and climate change adaptation: A need for transparency in policy assumptions and implications. *Environmental Science and Policy*, *171*(June), 104150. https://doi.org/10.1016/j.envsci.2025.104150

Cissé, G., McLeman, R., Adams, H., Aldunce, P., Bowen, K., Cambell-Lendrum, D., Clayton, S., Ebi, K. L., Hess, J., Huang, C., Liu, Q., McGregor, G., Semenza, J., & Tirado, M. C. (2022). Health, Wellbeing and the Changing Structure of Communities. In H.-O. Pörtner, D. C. Roberts, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Loschke, V. Moller, A. Okem, & B. Rama (Eds.), *Climate Change 2022: Impacts, Adaptation and Vulnerability* (pp. 1041–1170). Cambridge University Press. https://doi.org/10.1017/9781009325844.009

De-Clippele, L. H., Diaz, L. A., Andradi-Brown, D. A., Lazuardi, M. E., Iqbal, M., Zainudin, I. M., Prabuning, D., Hooidonk, R. van, Hakim, A., Agung, F., Dermawan, A., &

Hennige, S. J. (2023). Evaluating annual severe coral bleaching risk for marine protected areas across Indonesia. *Marine Policy*, *148*. https://doi.org/https://doi.org/10.1016/j.marpol.2022.105428

DPKP NTT. (2025). *Laporan Keterangan Pertanggungjawaban 2024 [2024 Accountability Statement Report]*.

Enescu, C. M., Mihalache, M., Ilie, L., Dinca, L., Constandache, C., & Murariu, G. (2025). Agricultural benefits of shelterbelts and windbreaks: A bibliometric analysis. *Agriculture*, *15*(11), 1–30. https://doi.org/10.3390/agriculture 15111204

ESDM. (2023). *Statistik Ketenagalistrikan Tahun 2022 [Electricity Statistics 2022]* (F. Rahmadhy, S. Barir, K. Dewi, B. S. A. Nugroho, & F. D. Putra (eds.)). Kementerian Energi dan Sumber Daya Mineral.

FAO. (2023). *The World's Mangroves 2000 - 2020*. Food and Agriculture Organization of the United Nations. https://doi.org/https://doi.org/10.4060/cc7044en

FAO. (2025). *GIEWS Country Brief: The Republic of Indonesia*.

Fernandez-Novo, A., Perez-Garnelo, S. S., Villagra, A., Perez-Villalobos, N., & Astiz, S. (2020). The effect of stress on reproduction and reproductive technologies in beef cattle: A review. *Animals*, *10*. https://doi.org/10.3390/ani10112096

Genter, F., Putri, G. L., Pratama, M. A., Priadi, C., Willetts, J., & Foster, T. (2022). Microbial contamination of groundwater self-supply in urban Indonesia: Assessment of sanitary and socio-economic risk factors. *Water Resources Research*, *58*. https://doi.org/https://doi. org/10.1029/2021WR031843

Government of Indonesia. (2021). *Indonesia's Long-Term Strategy for Low Carbon and Climate Resilience 2050*.

Government of Indonesia. (2022a). *Enhanced Nationally Determined Contribution*.

Government of Indonesia. (2022b). Indonesia's Adaptation Communication. In *UNFCCC*. www.menlhk.go.id

Government of Indonesia. (2024a). *Indonesia First Biennial Transparency Report (BTR)*.

Government of Indonesia. (2024b). *Republic of Indonesia National Adaptation Plan Framework*.

Habibullah, A. D., Tarya, A., Ningsih, N. S., & Putri, M. R. (2023). Marine heatwaves in the Indonesian fisheries management areas. *Marine Science and Engineering*, *11*. https://doi.org/https://doi.org/10.3390/jmse11010161

Hamlington, B. D., Frederikse, T., Thompson, P. R., Willis, J. K., Nerem, R. S., & Fasullo, J. T. (2021). Past, Present, and Future Pacific Sea-Level Change. *Earth's Future*, *9*(4). https://doi.org/https://doi.org/10.1029%2F2020EF001839

Hamuna, B., Tanjung, R. H. R., Suwito, S., Maury, H. K., & Alianto, A. (2018). Kajian Kualitas Air Laut dan Indeks Pencemaran Berdasarkan Parameter Fisika-Kimia di Perairan Distrik Depapre, Jayapura. *Jurnal Ilmu Lingkungan*, *16*(1), 35. https://doi.org/10.14710/jil.16.1.35-43

Handiani, D. N., Heriati, A., & Suciaty, F. (2022). Coastal vulnerability assessment along the North Java Coastlines-Indonesia. *SEGARA*, *18*(1), 1–12. http://ejournal-balitbang.kkp.go.id/index.php/segara

Harsoyo, B. (2010). Jebolnya tanggul Situ Gintung (27 Maret 2009) bukan karena faktor curah hujan ekstrim. *Sains Dan Teknologi Modifikasi Cuaca*, *11*(1), 9–17.

Hein, L., Spadaro, J. V, Ostro, B., Hammer, M., Sumarga, E., Salmayenti, R., Boer, R., Tata, H., Atmoko, D., & Castaneda, J.-P. (2022). The health impacts of Indonesian peatland fires. *Environmental Health*, *21*(62). https://doi.org/https://doi.org/10.1186/s12940-022-00872-w

ILO. (2019). *Working on a warmer planet: The impact of heat stress on labour productivity and decent work*.

IPCC. (2019). Summary for Policymakers. In H.-O. Pörtner, D. C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, & N. M. Weyer (Eds.), *IPCC Special Report on the Ocean and Cryosphere in a Changing Climate* (pp. 3–35). Cambridge University Press. https://doi.org/10.1017/9781009157964

IPCC. (2022a). *Climate Change 2022: Impacts, Adaptation and Vulnerability* (H.-O. Pörtner, D. C. Roberts, M. Tignor, E. S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Loschke, V. Moller, A. Okem, & B. Rama (eds.)). Cambridge University Press. https://doi.org/10.1017/9781009325844

IPCC. (2022b). Summary for Policymakers. In H.-O. Pörtner, D. C. Roberts, E. S. Poloczanska, K. Mintenbeck, M. Tignor, A. Alegría, M. Craig, S. Langsdorf, S. Loschke, V. Moller, & A. Okem (Eds.), *Climate Change 2022: Impacts, Adaptation and Vulnerability* (pp. 3–33). Cambridge University Press. https://doi.org/10.1017/9781009325844.001

IPCC. (2023). Ocean, Cryosphere and Sea Level Change. In *Climate Change 2021 – The Physical Science Basis*. https://doi.org/10.1017/9781009157896.011

Kaczan, D., Nurhabni, F., Cheung, W., Frolicher, T., Kuswardani, A., Lam, V., Muawanah, U., Puspasari, R., Reygondeau, G., Sumaila, U., & Teh, L. (2023). *Hot Water Rising: The Impact Of Climate Change On Indonesia's Fisheries And Coastal Communities*. The World Bank.

Kemenkes. (2022). *Hasil Survei Status Gizi Indonesia (SSGI) 2022 [Results of the 2022 Indonesian Nutritional Status Survey (SSGI)]*.

Kemenkes. (2023). *Survei Kesehatan Indonesia (SKI) [Indonesia Health Survey (SKI)]*.

Kemenkes. (2025a). *Laporan Penilaian Kerentanan dan Adaptasi Perubahan iklim dan Kesehatan di Indonesia [Climate Change and Health Vulnerability and Adaptation Assessment Report in Indonesia]*.

Kemenkes. (2025b). *Pedoman Penilaian Fasyankes Berketahanan Iklim dan Lestari Lingkungan di Indonesia: Climate-Resilient and Environmentally Sustainable Healthcare Facility (CRESHCF)*. Kementerian Kesehatan.

Kemenkes. (2025c). *Survei Status Gizi Indonesia 2024 [Indonesian Nutritional Status Survey 2024]*.

Kemenkeu. (2021). *Indonesia's GCF Country Programme Document*.

Kementan. (2023). *Deskripsi Varietas Unggul Baru Padi 2023*.

Kementan. (2024). *Analisis Kinerja Perdagangan Jagung* (Saefudin & S. Wahyuningsih (eds.)). Pusat Data dan Sistem Informasi Pertanian.

Kengkanna, J., Jakaew, P., Amawan, S., Busener, N., Bucksch, A., & Saengwilai, P. (2019). Phenotypic variation of cassava root traits and their responses to drought. *Applications in Plant Sciences*, *4*, 1–14. https://doi.org/10.1002/aps3.1238

Kennedy, E. V, Vercelloni, J., Neal, B. P., Amariyanto, Bryant, D. E. P., Ganase, A., Gartell, P., Brown, K., Kim, C. J. S., Hudatwi, M., Hadi, A., Prabowo, A., Prihatinningsih, P., Haryanta, S., Markey, K., Green, S., Dalton, P., Lopez-Marcano, S., Rodriguez-Ramirez, A., … Hoegh-Guldberg, O. (2020). Coral reef community changes in Karimunjawa National Park, Indonesia: assessing the efficacy of management in the face of local and global stressors. *Marine Science and Engineering*, *8*(760). https://doi.org/10.3390/jmse8100760

Khairina, S. A., & Widiarti, I. W. (2024). Analisis kualitas air tanah di sekitar TPST Bantargebang, Kecamatan Bantargebang, Kota Bekasi, Jawa Barat. *Seminar Nasional Teknik Lingkungan Kebumian SATU BUMI*. https://doi.org/10.31315/psb.v6i1.14446

Khairunnisa, A., Ihsan, & Patandianan, M. (2023). Risk burden of heat-related morbidity due to urban heat island effect in Tamalanrea District, Makassar. *Media Kesehatan Masyarakat Indonesia*, *19*(4), 149–158. https://doi.org/10.30597/mkmi.v19i4.26691

Khalil, A., Moeller-Gulland, J., Ward, C., Al'Afghani, M. M., Perwitasari, T., Octaviani, K., Riani, E., Liao, X., & Khan, A. M. (2021). *"Indonesia:Vision 2045", Towards Water Security* (Water Secu). World Bank Group.

KKP. (2024). *Laporan Kinerja Kementerian Kelautan dan Perikanan 2024 [Ministry of Maritime Affairs and Fisheries Performance Report 2024]*.

KLH/BPLHK. (2020). *Roadmap Nationally Determined Contribution (NDC) Climate Change Adaptation: Technical Book*. Kementerian Lingkungan Hidup dan Kehutanan.

KLHK. (2021a). *Climate Change Vulnerability Profile of Indonesian Coral Triangle Region*. Kementerian Lingkungan Hidup dan Kehutanan.

KLHK. (2021b). *Kajian Kerentanan dan Risiko Ekosistem Mangrove terhadap Perubahan Iklim di Indonesia*. Kementerian Lingkungan Hidup dan Kehutanan.

KLHK. (2022). *The State of Indonesia's Forests 2022: Towards FOLU Net Sink 2030*.

Klipper, I. G., Zipf, A., & Lautenbach, S. (2021). Flood impact assessment on road network and healthcare access at the example of Jakarta, Indonesia. In P. Partsinevelos, P. Kyriakidis, & M. Kavouras (Eds.), *AGILE Conference on Geographic Information Science*. https://doi.org/https://doi.org/10.5194/agile-giss-2-4-2021

Lawrence, J., Blackett, P., & Cradock-Henry, N. A. (2020). Cascading climate change impacts and implications. *Climate Risk Management*, *29*. https://doi.org/https://doi.org/10.1016/j.crm.2020.100234

Lubis, M. I. A., Hasibuan, H. S., Alexander, D., & Nasution, A. M. (2024). Preliminary analysis to optimise the drying process of mini vertical silo dryer. *IOP Conference Series: Earth and Environmental Science*, *1426*(1). https://doi.org/10.1088/1755-1315/1426/1/012010

Mangan, M., & Siwek, M. (2024). Strategies to combat heat stress in poultry production—A review. *Animal Physicology and Animal Nutrition*, *108*. https://doi.org/10.1111/jpn.13916

Moreno-Cadena, P., Hoogenboom, G., Cock, J. H., Ramirez-Villegas, J., Pypers, P., Kreye, C., Tariku, M., Ezui, K. S., Lopez-Lavalle, L. A. B., & Asseng, S. (2021). Modeling growth, development and yield of cassava: A review. *Field Crops Research*, *267*. https://doi.org/https://doi.org/10.1016/j.fcr.2021.108140

Murdiyarso, D., Purbopuspito, J., Kauffman, J. B., Warren, M. W., Sasmito, S. D., Donato, D. C., Manuri, S., Krisnawati, H., Taberima, S., & Kurnianto, S. (2015). The potential of Indonesian mangrove forests for global climate change mitigation. *Nature Climate Change*, *5*, 1089–1092. https://doi.org/https://doi.org/10.1038/nclimate2734

Muzaky, H., & Jaelani, L. M. (2019). Analysis of the impact of land cover on surface temperature distribution: urban heat island studies in Medan and Makassar. *IOP Conference Series: Earth and Environmental Science*. https://doi.org/10.1088/1755-1315/389/1/012047

Ningsih, N. S., Beliyana, E., Kamila, I. H., & Tarya, A. (2025). Long-term characteristics of marine heatwaves (1982–2021) in Indonesian water and their impact on upwelling (case study: Southern Java). *Marine Science*, *12*. https://doi.org/10.3389/fmars.2025.1504995

Novianti, Zaman, B., & Sarminingsih, A. (2022). Kajian status mutu air dan identifikasi sumber pencemaran Sungai Cidurian segmen hilir menggunakan metode indeks pencemaran (IP). *Ilmu Lingkungan*, *20*(1), 22–29. https://doi.org/10.14710/jil.20.1.22-29

Nugroho, T. F., Wardhana, E. M., & Azmi, R. naufal. (2018). Stress analysis of land subsidence effect on header pipe 12 inch in lpg station Semarang. *Marine Engineering Innovation and Research*, *2*(4), 261–268.

OECD. (2023). *Water Financing and Disaster Risk Reduction in Indonesia: Highlights of a National Dialogue on Water* (OECD Studi). OECD Publishing. https://doi.org/https://doi.org/10.1787/3205b20a-en

Oke, O. E., Akosile, O. A., Uyanga, V. A., Oke, F. O., Oni, A. I., Tona, K., & Onagbesan, O. M. (2024). Climate change and broiler production. *Veterinary Medicine and Science*, *10*(3). https://doi.org/https://doi.org/10.1002/vms3.1416

Oliver, E. C. J., Burrows, M. T., Donat, M. G., Gupta, A. Sen, Alexander, L. V, Perkins-Kirkpatrick, S. E., Benthuysen, J. A., Hobday, A. J., Holbrook, N. J., Moore, P. J., Thomsen, mads S., Wernberg, T., & Smale, D. A. (2019). Projected Marine Heatwaves in the 21st Century and the Potential for Ecological Impact. *Marine Science*, *6*. https://doi.org/https://doi.org/10.3389/fmars.2019.00734

Parmesan, C., Morecroft, M. D., Trisurat, Y., Adrian, R., Anshari, G. Z., Arneth, A., Gao, Q., Gonzalez, P., Harris, R., Price, J., Stevens, N., & Talukdar, G. H. (2022). Terrestrial and Freshwater Ecosystems and Their Services. In H.-O. Pörtner, D. C. Roberts, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, & B. Rama (Eds.), *Climate Change 2022: Impacts, Adaptation and Vulnerability* (Contributi, pp. 197–377). Cambridge University Press. https://doi.org/10.1017/9781009325844.004.

PLN. (2023). *Climate-Related Disclosure 2023*.

Pradesi, R. F., Sumarsono, A., & Emiliawati, A. (2023). Analisis pengaruh variabilitas curah hujan terhadap perubahan debit sungai, karakteristik hidrlogis, dan resiko banjir (studi kasus : Sungai Musi Desa Muara Kelingi). *Sipil Dan Perencanaan Musi Rawas*, *1*(2), 59–68. https://www.ejurnal.unmura.org/index.php/jsp/article/view/245

Prayitno, H. B., Puspitasari, R., Jandang, S., & Triana, K. (2020). Establishing ocean acidification monitoring system for tropical waters of indonesia facing regional climate variability. *ASEAN Journal on Science and Technology for Development*, *37*(3), 123–133. https://doi.org/10.29037/ajstd.638

PUPR. (2024). Air Untuk Negeri: Modernisasi Irigasi dan Upaya Menjaga Ketahanan Pangan [Water for the Nation: Modernizing Irrigation and Efforts to Maintain Food Security]. *Ketahanan Air Untuk Ketahanan Pangan*.

Putriningtias, A., Bahri, S., Faisal, T. M., & Harahap, A. (2021). Water quality in coastal area of Ujung Perling Island, Langsa City, Aceh. *Habitus Aquatica: Journal of Aquatic Resources and Fisheries Management*, *2*(2), 95–99.

Rajabson, M. H. S., Rachmayani, R., & Sarasvati, P. N. (2023). Kesesuaian kondisi oseanografi dalam mendukung ekosistem terumbu karang di pantai mengiat, Nusa Dua Bali. *Applied Environmental Science*, *1*(1), 12–18. https://doi.org/10.61511/aes.v1i1.2023.60

Ranashinghe, R., Ruane, A. C., Vautard, R., Arnell, N., Coppola, E., Cruz, F. A., Dessai, S., Islam, A. K. M. S., Rahimi, M., Carrascal, D. R., Sillman, J., Sylla, M. B., Tebaldi, C., Wang, W., & Zaaboul, R. (2021). Climate Change Information for Regional Impact and for Risk Assessment. In V. Masson-Delmotte, P. Zhai, A. Pirani, S. L. Connors, C. Pean, N. Caud, Y. Chen, L. Goldfarb, M. I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J. B. R. Matthews, T. K. Maycock, T. Waterfield, O. Yelekci, R. Yu, & B. Zhou (Eds.), *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 1767–1926). Cambridge University Press. https://doi.org/10.1017/9781009157896.014

Rini, I. P., Nurtanti, R. A., Chatistareta, E. Z., Parawida, A. T., Nabiilah, A. D. Q., Hadyansyah, E. I., & Daffa, F. R. (2025). Peran terasering Dalam menekan laju erosi tanah pada lahan pertanian. *Warta Sumber Daya Lahan Pertanian*, *2*(2), 1–32.

Rugebregt, M. J., Opier, R. D. A., Abdul, M. S., Triyulianti, I., Kesaulya, I., Widiaratih, R., Sunuddin, A., & Kalambo, Y. (2023). Changes in pH associated with temperature and salinity in the Banda Sea. *IOP Conference Series: Earth and Environmental Science*, *1163*(1). https://doi.org/10.1088/1755-1315/1163/1/012001

Saragih, L. A., Ismunarti, D. H., Kunarso, & Hatmaja, R. B. (2025). Analisis karakteristik marine heatwaves di wilayah pengelolaan perikanan 711. *Indonesian Journal of Oceanography*, *7*(2), 181–189. https://doi.org/10.14710/ijoce.v7i2.26386

Sarah, D. (2022). Land subsidence hazard in Indonesia: Present research and challenges ahead. *Riset Geologi Dan Pertambangan*, *32*(2), 83–100. https://doi.org/10.14203/risetgeotam2022.v32.1195

Sektiawan, A., Prasetyo, G. A., Adli, D. P., & Yuantoro, E. (2016). Subsidence: Causes, effects, and mitigations in geothermal field. *Earth and Environmental Science*. https://doi.org/10.1088/1755-1315/42/1/012022

Setiawan, A., Mentari, D. M., Hakam, D. F., & Saraswani, R. (2025). From climate risks to resilient energy systems: addressing the implications of climate change on Indonesia's energy policy. *Energies*, *18*, 2389. https://doi.org/https://doi.org/10.3390/en18092389

Setiawan, F., Muttaqin, A., Tarigan, S. A., Muhidin, Hotmariyah, Sabil, A., & Pinkan, J. (2017). Pemutihan karang akibat pemanasan global tahun 2016 terhadap ekosistem terumbu karang: Studi kasus di twp Gili Matra (Gili Air, Gili Meno dan Gili Trawangan) Provinsi NTB. *Fisheries and Marine Science*, *1*(2), 39–54. http://jfmr.ub.ac.id

Shaw, R., Luo, Y., Cheong, T. S., Halim, S. A., Caturvedi, S., Hashizume, M., Insarov, G. E., Ishikawa, Y., Jafari, M., Kitoh, A., Pulhin, J. M., Singh, C., Vasant, K., & Zhang, Z. (2022). Asia. In H.-O. Pörtner, D. C. Roberts, M. Tignor, E. S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Loschke, V. Moller, A. Okem, & B. Rama (Eds.), *Climate Change 2022: Impacts, Adaptation and Vulnerability* (pp. 1457–1579). Cambridge University Press. https://doi.org/doi:10.1017/9781009325844.012

Siswanto, Nuryanto, D. E., Ferdiansyah, M. R., Prastiwi, A. D., Dewi, O. C., Gamal, A., & Dimyati, M. (2023). Spatio-temporal characteristics of urban heat Island of Jakarta metropolitan. *Remote Sensing Applications: Society and Environment*, *32*, 1–15. https://doi.org/https://doi.org/10.1016/j.rsase.2023.101062

Situmorang, D., Arhatin, R. E., & Lumban-Gaol, J. (2021). Land subsidence detection in Jakarta Province using Sentinel-1A Satellite Imagery. *IOP Conference Series: Earth and Environmental ScienceEarth and Environmental Science*. https://doi.org/10.1088/1755-1315/944/1/012036

Supriyadi, Fitrianto, T. N., Khumaedi, & Sugiyanto. (2021). Identification of Seawater Intrusion in Kota Lama Semarang and Surrounding Based on Geoelectrical Resistivity Survey. *Journal of Physics: Conference Series*, *2019*. https://doi.org/10.1088/1742-6596/2019/1/012087

Suryahadi, A. (2025). *The Middle Class in Indonesia: The Shrinking Engine of Growth*.

Suryana, E. A., Mauludyani, A. V. R., Sumedi, Ariani, M., & Munarso, S. J. (2024). Reducing post-harvest loss and waste along the rice supply chain and consumption. *BIO Web of Conferences*, *119*. https://doi.org/10.1051/bioconf/202411901013

Thornton, P., Nelson, G., Mayberry, D., & Herrero, M. (2021). Increases in extreme heat stress in domesticated livestock species during the twenty-first century. *Global Change Biology*, *27*, 5762–5772. https://doi.org/10.1111/gcb.15825

Tito, C. K., Susilo, E., & Sasongko, R. D. (2023). The response of tuna to ocean acidification in Indonesian waters (Case study: Gulf of Bone). *IOP Conference Series: Earth and Environmental Science*, *1251*(1). https://doi.org/10.1088/1755-1315/1251/1/012019

UN Women. (2022). *Annual Report for ASIA and the Pacific 2020 - 2021*.

UNCBD. (2022). *Kunming-Montreal Global Biodiversity Framework*.

UNDP. (2021). *Budgeting for Climate Change: A Guidance Note for Governments to Integrate Climate Change into Budgeting*.

UNDP. (2025). *Human Development Report 2025 , A matter of choice: People and Possibilities in the age of AI*.

UNDRR. (2022). *Global Assessment Report on Disaster Risk Reduction 2022: Our World at Risk: Transforming Governance for a Resilient Future*.

UNDRR, & UNU-EHS. (2023). *Nature-based Solutions for Comprehensive Disaster and Climate Risk Management*. https://www.undrr.org/publication/nature-based-solutions-comprehensive-disaster-and-%0Aclimate-risk-management

UNFCCC. (2010). *Decision 1/CP.16 from Report of the Conference of the Parties on Its Sixteenth Session*.

UNFCCC. (2011). *Decision 5/CP.17 from Report of the Conference of the Parties (COP) on Its Seventeenth Session*.

UNFCCC. (2015). *The Paris Agreement from the Paris Climate Change Conference on COP 21*.

UNFCCC. (2021). *Desicion 7/CMA.3 from Report of the Conference of the Parties Serving as the Meeting of the Parties to the Paris Agreement on Its Third Session*.

UNFCCC. (2025a). *Joint Annual Report: The Executive Committee of the WIM and the Santiago Network*.

UNFCCC. (2025b). *NAP Technical Guidelines*.

UNICEF. (2023). *Climate Landscape Analysis for Children in Indonesia*. United Nations Children's Fund.

USAID. (2016). *Indonesia: Costs of Climate Change 2050*. United States Agency for International Development.

Vandana, G. D., Sejian, V., Lees, A. M., Pragna, P., Silpa, M. V, & Maloney, S. K. (2020). Heat stress and poultry production: impact and amelioration. *International Journal of Biometeorology*, *65*, 163–179. https://doi.org/https://doi.org/10.1007/s00484-020-02023-7

Wenga, T., Gwenzi, W., Ali, I., & Ma, W. (2024). Heliyon high-temperature corrosion-resistant alloy for waste-to-energy plants : Alloy designing , fabrication , and possible corrosion-resistance mechanism. *Heliyon*, *10*(9). https://doi.org/10.1016/j.heliyon.2024.e30177

WHO. (2015). *Climate and Health Country Profile of Indonesia 2015*.

WHO, & WMO. (2025). *Climate Change and Workplace Heat Stress: Technical Report and Guidance*.

Widyati, E., Nuroniah, H. S., Tata, H. L., Mindawati, N., Lisnawati, Y., Darwo, Abdulah, L., Lelana, N. E., Mawazin, Octavia, D., Prameswari, D., Rachmat, H. H., Sutiyono, Darwiati, W., Wardani, M., Kalima, T., Yulianti, & van Noordwijk, M. (2022). Soil degradation due to conversion from natural to plantation forests in Indonesia. *Forests*, *13*(11), 1–21. https://doi.org/10.3390/f13111913

Wihardjaka, A., Pramono, A., & Sutriadi, M. T. (2020). Peningkatan produktivitas padi sawah tadah hujan melalui penerapan teknologi adaptif dampak perubahan iklim. *Jurnal Sumberdaya Lahan*, *14*(1). https://doi.org/10.21082/jsdl.v14n1.2020.25-36

World Bank. (2016). *The Cost of Fire: An Economic Analysis of Indonesia's 2015 Fire Crisis* (Indonesia). World Bank Group.

World Bank. (2018). *Meningkatkan Keamanan Bendungan Dan Perlindungan Masyarakat Umum Melalui Rencana Tindak Darurat Dan Rencana Kontinjensi Berbasis InaSAFE [Enhancing Dam Safety and Public Protection Through InaSAFE-Based Emergency Action Plans and Contingency Plans]*. World Bank Group.

World Bank. (2021). *Climate Smart Agriculture in Indonesia*.

World Bank. (2023). *Country Climate and Development Report: Indonesia*.

World Bank. (2025). *Climate Risk Country Profile: Indonesia*.

Cover photo copyright from left to right:

Hospital © Piarea, 2025

Kontamale Cave © Ika R Suratno, GIZ, 2025

Crops © Dian Ariestyowati, MoE/EPA, 2025

Pongo sp Orangutan © Lili Aini MoF, 2017

Slow onset flood in Simonet, Pekalongan © ZCRA, MCI, 2024

ANNEX

Annex 1. Sectoral Adaptation Matrix for Food Security & Agriculture

Impact Code	Impacts / Risks Addressed	Adaptation Action (ENDC Annex 2)	Feasible Adaptation Measure (operational detail)	Geographic Focus (Hotspots)	Beneficiaries	Benefits (Tangible & Intangible)	Technology Needs	Capacity & Skills Required	Timeline	Responsible Agencies
FS-01	Yield decline from drought & heat stress	Development & implementation of climate-adaptive technologies	Varieties drought/ heat-tolerant rice & maize; AWD irrigation; mulch/soil-moisture management; climate-smart planting windows	Java (west java, central java); NTT; South Sulawesi (Barru, Bone, Luwu, Sinjai, Wajo)	Smallholders; women farmers	Yield stability; reduced water stress; income resilience	Improved seeds; irrigation scheduling apps; on-farm sensors	Extension services; ICT literacy	2026–2030	Kementan; BRIN; BMKG; PUPR; Local goverment,
FS-02	Flood-related crop damage (rice/maize)	Improved water management systems	Canal/drainage rehab; flood-resilient varieties; smart gate control; raised beds in horticulture	North Sumatra (Nias, Nias Barat, Padang Lawas); West Kalimantan; Central Java	Farmers; WUAs	Lower crop loss; better water allocation	IoT soil-moisture & level sensors; telemetry	WUA O&M; PUPR coordination	2026–2030	Kementan; PUPR; BBWS
FS-03	Pest & disease outbreaks under warming/ humidity	Improve crop protection from pests & diseases	Climate-informed IPM; resistant cultivars; biocontrol/ biopesticides; pest EWS with BMKG data; Cultivation technology supporting IPM	Lampung; East Java; Bali	Farmers; local agribusiness	Loss reduction; input savings	Pest monitoring/ EWARS tools	IPM training; extension networks	2026–2030	Kementan; BMKG; Local goverment
FS-04	Income loss from climate shocks	Financing scheme for agriculture	Weather-indexed crop insurance; bundled microcredit for CSA inputs; savings groups; rice farming business protection (AUTP) to protect rice farming businesses that experience crop failure due to floods, drought and pest attacks	West Java; South Sumatra (Kota Pagar Alam, Kota Lubuklinggau); NTB (Bima)	Smallholders; co-ops	Income stabilization; access to finance	Risk models; fintech/insurance platforms	Insurance literacy; co-op governance	2026–2030	Kementan; OJK; insurers
FS-05	Soil degradation & fertility decline	Mainstreaming adaptation & enhancing ecosystem services in agriculture	Conservation agriculture; agroforestry; ameliorants; soil testing & advisory	Java uplands (Wonosobo); degraded Sumatra fringes (Binjai, Karo)	Farmers; communities	Soil health; biodiversity; carbon co-benefits	Soil diagnostics; seedlings	Soil & agroforestry training; cross-sector collab	2030–2045	Kementan; KLH; BRIN
FS-06	Food insecurity & malnutrition in vulnerable HHs	Identification & best practices for farmers' economic empowerment	Nutrition-sensitive home gardens; diversified crops; agriculture–health linkage via Posyandu, diversified crops	Eastern Indonesia; NTT; Papua	Women; children; low-income HHs	Better diets; reduced stunting; equity	Low-cost irrigation; seed kits	Agri-nutrition extension; community facilitation	2026–2030	Kementan; Kemenkes; Social Affairs
FS-07	Windstorm damage to crops/livestock (puting beliung / strong wind)	Development & implementation of climate-adaptive technologies	Farm windbreaks; cyclone-resistant livestock shelters; reinforced post-harvest storage	Cyclone/ wind corridors (Sumba, Flores, SE Sulawesi); North coast Java	Farmers; herders	Reduced physical losses; faster recovery	Wind-load design; shelter materials	Local builders; farmer groups	2026–2030	Kementan; local gov'ts; BNPB (support)
FS-08	Salinity intrusion & coastal inundation lowering rice/ aquaculture productivity	Improved water management systems & climate-adaptive technologies	Salt-tolerant rice; freshwater pond buffers; dike/sluice rehab; integrated rice–fish–mangrove systems	North coast java; Riau; South Sulawesi deltas	Coastal smallholders; fish farmers	Maintained yields; livelihood security	Salinity sensors; intake control	Aquaculture & irrigation ops; coastal farmer training	2026–2035	Kementan; PUPR; KLH; local gov'ts
FS-09	High humidity causing post-harvest losses, aflatoxin & fungal disease	Development of climate-adaptive technologies & best practices	Hermetic storage; humidity-controlled silos; solar dryers; aflatoxin screening; harvest timing advisory	Humid lowlands (Sumatra, Kalimantan); rainy Java zones	Farmers; MSME aggregators	Quality & price stability; health protection	Moisture meters; solar dryers; rapid tests	Post-harvest management; quality control	2026–2030	Kementan; co-ops; BULOG partners
FS-10	Irrigation energy vulnerability (drought/ heat reducing pumping efficiency)	Improved water management systems	Solar-powered pumps; gravity/ pressurized piped systems; energy-efficient motors	Drought-prone schemes (NTT, NTB, Sulawesi)	Farmers; WUAs	Reliable delivery; OPEX savings	Solar PV pumps; variable-speed drives	Pump O&M; basic electrical	2026–2035	Kementan; PUPR; ESDM
FS-11	Supply-chain disruptions (flood/wind) to storage & logistics	Mainstreaming adaptation in agri sector; best practices	Climate-proofed warehouses; decentralized cold rooms; all-weather feeder roads	Flood-prone corridors (Pantura, Sumatra West)	Farmers; MSMEs; traders	Loss reduction; price stability	Raised-floor storage; solar cold rooms	Warehouse management; MSME logistics	2026–2035	Kementan; PUPR; Trade; local gov'ts
FS-12	Compound heat–humidity risk to field labor productivity	Development of climate-adaptive technologies & best practices	Heat-safe work protocols; shaded rest areas; hydration & scheduling; mechanization of peak-heat tasks	West Java (Kawarang), Central java (Sragen)	Farm workers; women laborers	Occupational safety; sustained labor productivity	WBGT monitors; shade structures	OHS training; farmer orgs	2026–2030	Kementan; Manpower; local gov'ts

Annex 2. Sectoral Adaptation Matrix for Water Security

Impact Code	Impacts / Risks Addressed	Adaptation Action (ENDC Annex 2)	Feasible Adaptation Measure (Operational Detail)	Geographic Focus (Hotspots)	Beneficiaries	Benefits (Tangible & Intangible)	Technology Needs	Capacity & Skills Required	Timeline	Responsible Agencies
WS-01	Dam and irrigation failure under extreme rainfall and sedimentation	Rehabilitation and climate-proofing of irrigation and storage infrastructure	Rehabilitation and climate-proofing of irrigation networks and dams; slope stabilization; spillway safety retrofits	Java (Wadaslintang, Brantas); Sumatra (Asahan); Sulawesi (Larona)	Farmers; BBWS/BWS; local communities	Reduced flood damage; sustained water supply for agriculture and urban areas	Real-time sediment sensors; geotextile revetment; remote monitoring apps	Dam safety O&M; geotechnical training	2026–2030	Kemen PU; BBWS/BWS; Local Gov't; Indonesian Water Council (Dewan Sumberdaya Air)
WS-02	Inefficient reservoir operation under climate variability	Integrated basin planning and adaptive operation rules	Integrated basin planning and operation rules using hydro-climatic data from BMKG; real-time reservoir management tools	Java and Kalimantan main basins	River-basin operators; farmers & urban users	Optimized water allocation; reduced conflicts	Decision-support software; SCADA platform	Hydro-climatic data interpretation; basin coordination	2026–2030	Kemen PU; BMKG; KLH
WS-03	Drought and groundwater depletion affecting villages and agriculture	Drought-management and emergency response programs	Drought management programs – drought alert system, groundwater automatic water level recorder,gully plug, infiltration well and emergency water trucking for critical villages	Java and NTT drylands	Rural communities; smallholders	Water availability during drought; health protection	Automated observation wells; satellite data feeds	Local response planning; community monitoring	2026–2030	BNPB; Kemen PU; Local Gov't
WS-04	Catchment degradation and erosion in upstream basins	Ecosystem-based watershed rehabilitation and forest management	Watershed rehabilitation and reforestation in degraded catchments; erosion control and check-dams	Citarum; Mahakam; Way Sekampung watersheds	Upland farmers; forest communities	Improved infiltration; reduced sediment load	Drone monitoring; seedling nurseries	Agroforestry training; watershed O&M	2026–2035	KLH; Kemenhut; Local Gov't
WS-05	Urban flooding from extreme rainfall and blocked drainage	Upgrading urban drainage and storm-water systems	Upgrading urban drainage and storm-water systems to handle extreme rainfall; nature-based flood retention	Jakarta; Semarang; Makassar urban areas	Urban residents; MSMEs	Reduced inundation; property protection	IoT flood sensors; GIS drain maps	Drainage asset management; PPP skills	2026–2035	Kemen PU; Local Gov't; BMKG
WS-06	Water-supply interruption for islands and coastal cities	Water-supply resilience for islands and coastal zones	Water-supply resilience for islands and coastal cities – desalination pilots, off-grid solar pumps, leak-loss control	NTT (Alor, Lembata); Maluku; Papua islands	Coastal households; utilities	Reliable access to safe water; reduced energy cost	Reverse-osmosis units; solar PV pumps	Utility O&M; renewable-tech training	2026–2035	Kemen PU; ESDM; Local Gov't
WS-07	Limited water storage in dry regions	Community-based rainwater harvesting and small reservoirs	Community-based rainwater harvesting systems; household storage tank[5]; small reservoirs in dry zones	NTT; NTB; East Java uplands	Rural communities; women's groups	Drought resilience; reduced water collection time	Low-cost tanks; geomembrane lining	WUA management; community training	2026–2030	Local Gov't; Kemen PU; BMKG
WS-08	Low urban and industrial water-use efficiency	Water-demand management and reuse	Grey-water reuse and low-flow appliances for urban water efficiency; industry water audits	Industrial estates (Jabodetabek, Surabaya)	Industries; urban households	Water and energy savings; pollution reduction	Smart meters; recycling units	Industrial water auditing; CSR programs	2026–2030	KLH; Kemen PU; Industry Ministry
WS-09	River and urban flood risk from extreme events	Flood-control channel rehabilitation and automation	Flood-control channel maintenance; smart gate control; pump automation using telemetry	Pantura corridor, Medan, Banjarmasin	Urban residents; farmers	Reduced losses, efficient drain operation	Pump automation; IoT control systems	Flood forecasting and alert training	2026–2030	Kemen PU; BBWS/BWS; BMKG
WS-10	Salinity intrusion and coastal freshwater loss	Coastal barriers and mangrove buffers	Salinity barriers and mangrove buffers to protect freshwater intakes in coastal zones	North Coast Java; South Sulawesi deltas	Coastal farmers; aquaculture groups	Protected intakes; livelihood security	Salinity sensors; mangrove nurseries	Coastal engineering; community restoration	2026–2035	KLH; Kemen PU; KKP; Local Gov't
WS-11	Fragmented data and weak coordination among agencies	Digital water information systems and data integration	Development of digital water information systems for real-time monitoring and data sharing	National; priority river basins	Ministries; provincial water agencies	Transparent decision-making; faster response	IoT sensors; cloud database	Data science; ICT for water management	2026–2030	Kemen PU; BMKG; KLH; Bappenas
WS-12	Limited technical capacity of local water managers	Capacity development for IWRM and climate-risk integration	Capacity development for river-basin agencies and local water managers on IWRM and climate-risk integration	Nationwide; river-basin centers	Water managers; academia	Enhanced institutional capacity; improved service delivery	E-learning platforms; training manuals	Basin planning; climate-risk analysis	2026–2035	Kemen PU; KLH; Bappenas; Universities

Annex 3. Sectoral Adaptation Matrix for Energy Security

Impact Code	Impacts / Risks Addressed	Adaptation Action (ENDC Annex 2)	Feasible Adaptation Measure (Operational Detail)	Geographic Focus (Hotspots)	Beneficiaries	Benefits (Tangible & Intangible)	Technology Needs	Capacity & Skills Required	Timeline	Responsible Agencies
EN-01	Decline in hydropower generation due to variable inflows and sedimentation	Enhancing renewable system resilience & diversification	Climate-proofing of hydropower plants – integrate BMKG rainfall projections, sediment-management, adaptive reservoir rules	Sumatra (Asahan); Java (Brantas); Sulawesi (Larona)	PLN; farmers; local industries	Sustained power output; reduced flood risk	Decision-support software; sediment sensors; remote-monitoring tools	Hydrology modelling; dam safety and O&M; water management	2026–2030	Kemen ESDM; Kemen PU; PLN; BMKG
EN-02	Coastal flooding and storm surge damaging energy assets	Protection of coastal and deltaic energy facilities	Protection of coastal and deltaic energy assets – elevation, flood barriers, corrosion-resistant materials	North Coast Java; Balikpapan; Dumai; Makassar	PLN; Pertamina; local communities	Reduced outage risk; asset protection	Early-warning system integration; structural retrofitting	Engineering design; coastal protection training	2026–2030	Kemen ESDM; Kemen PU; KLH; Pertamina
EN-03	Transmission-line failure due to storms and heat stress	Grid-resilience strengthening and modernization	Grid-resilience strengthening – heat-resistant conductors, storm-hardening of towers, smart-grid fault isolation	Java–Sumatra interconnection; Sulawesi grid; NTT; Maluku; Bali	PLN; consumers; local industries	Fewer power disruptions; improved service reliability	Smart-grid components; GIS-based asset registry	Utility asset management; digital operations; storm early warning system	2026–2035	PLN; Kemen ESDM; KLH
EN-04	Lack of climate-risk consideration in investment planning	Risk-informed planning and asset management	Risk-informed planning & asset management – use climate scenarios in energy-infrastructure appraisals	Nationwide (planning units)	Energy regulators; investors	Better risk-adjusted investment decisions	GIS-based risk maps; climate-screening templates	Project appraisal; climate-risk analysis	2026–2030	Kemen ESDM; KLH; Bappenas
EN-05	Dependence on vulnerable fossil-supply chains	Diversification through adaptive renewable energy and bioenergy	Diversification through bioenergy & waste-to-energy pilots – adaptive feedstock sourcing, methane-capture	Java; Sumatra; Kalimantan	Urban utilities; waste managers	Diversified supply; emission co-benefits	Biogas digesters; gasification units	Feedstock logistics; O&M training	2026–2035	Kemen ESDM; KLH; Local Gov't; Private Sector
EN-06	Vulnerability of agriculture and fisheries to energy insecurity	Solar-powered irrigation and cold-storage systems for food–water–energy nexus	Solar-powered irrigation & cold-storage units supporting food–water–energy nexus	Eastern Indonesia; coastal zones	Farmers; fishers; women groups	Energy access; reduced losses; cost savings	Solar PV kits; hybrid controllers	Technical training; cooperative management	2026–2030	Kemen ESDM; Kementan; Kemen PU; Local Gov't
EN-07	Isolated communities reliant on diesel generation	Expansion of decentralized hybrid micro-grids	Expansion of decentralized hybrid micro-grids (solar + micro-hydro) for island electrification	Eastern islands (NTT, Maluku, Papua)	Rural communities; MSMEs	Reliable electricity; lower OPEX; reduced isolation	Hybrid inverters; battery banks	Micro-grid O&M; community energy management; local technicians	2026–2035	Kemen ESDM; Local Gov't; PLN; BRIN
EN-08	Energy-intensive water and sanitation systems	Energy-efficiency retrofits for pumping and treatment plants	Energy-efficiency retrofits for pumping – variable-speed drives, optimized scheduling	Urban utilities (Jakarta, Surabaya, Medan)	Water utilities; local residents	Reduced energy cost; sustained water service	SCADA systems; efficient pumps	Operator training; audit methods	2026–2035	Kemen PU; Kemen ESDM; Water Utilities
EN-09	Rising energy demand for cooling in buildings	Energy-efficient design and retrofits	Passive-cooling & efficient-building programs – reflective roofs, ventilation retrofits for public facilities	Urban public facilities; hospitals; schools (Jakarta, Surabaya, Medan)	Households; patients; students; businesses; Industries	Reduced cooling load; health benefits; climate-comfort	Reflective coatings; insulation materials	Building retrofitting; O&M skills	2026–2030	Kemen ESDM; Kemen Perkim; Local Gov't
EN-10	Outage risk for critical facilities during disasters	Backup power and storage systems for essential services	Backup-power & energy-storage systems for critical facilities (hospitals, WTPs, evacuation centers)	Nationwide critical-infrastructure nodes (Java–Bali grids, Balikpapan)	Hospitals; public services; emergency services	Continuity of essential services; faster recovery	Modular battery systems; quick-connect switchgear	Emergency O&M; logistics management	2026–2030	Kemen ESDM; Kemen PU; BNPB; PLN
EN-11	Limited innovation and local technology development	Renewable-energy R&D and innovation networks	Renewable-energy R&D and innovation networks – resilience design, modular PV & storage testing	BRIN centers; university partnerships	Researchers; private developers	Technology localization; cost reduction	Simulation platforms; testing labs	R&D collaboration; IP management	2026–2035	Kemen ESDM; BRIN; Universities
EN-12	Low institutional and human-resource capacity on climate-risk management	Capacity development for utilities and local operators	Capacity development for utilities and local operators on climate-risk management & emergency response	National; provincial energy offices	Utility staff; local engineers	Improved adaptive management; disaster readiness	E-learning systems; curricula	Climate-risk integration; emergency drills	2026–2035	Kemen ESDM; KLH; PLN; Universities

Annex 4. Sectoral Adaptation Matrix for Health Security

Impact Code	Impacts / Risks Addressed	Adaptation Action (ENDC Annex 2)	Feasible Adaptation Measure (Operational Detail)	Geographic Focus (Hotspots)	Beneficiaries	Benefits (Tangible & Intangible)	Technology Needs	Capacity & Skills Required	Timeline	Responsible Agencies
HS-01	Flooding and heat extremes affecting health facilities	Strengthening climate-resilient health infrastructure and service	Climate-resilient and Environmentally Sustainable Health Care Facilities	Coastal and flood-prone districts (Jakarta, Semarang, Banjarmasin)	Patients; medical staff; local residents	Continuous healthcare service; reduced facility damage	Solar back-up; modular water-storage; climate-proof materials	facility engineers; emergency facility O&M	2026–2030	Kemenkes; Kemen PU; KLH; Local Gov't
HS-02	Increased incidence of climate-sensitive diseases (dengue, malaria, diarrhea)	Development of early-warning and surveillance systems	Establishment of Climate–Health Early Warning System (CHEWS) linking BMKG data with disease surveillance platforms	Java, NTT, South Kalimantan, Papua	Health officers; local communities; Children	Timely alerts; reduced outbreaks	CHEWS data platform; mobile alert apps	Data analysis; inter-agency coordination	2026–2030	Kemenkes; KLH; BMKG; Bappenas
HS-03	Inadequate consideration of climate risks in facility development	Integration of climate-risk screening into accreditation & investment planning	Integration of climate-risk screening into health-facility accreditation and investment review processes	National	Health administrators; planning units	Reduced maladaptation; efficient resource allocation	Risk-screening templates; GIS hazard maps	Planning and regulatory capacity	2026–2030	Kemenkes; KLH; Bappenas
HS-04	Poor sanitation and waste management intensifying disease spread	Strengthening community-based sanitation and vector control	Improvement of vector-control and water-sanitation systems – community-based climate/environment action and drainage maintenance	Urban slums; peri-urban settlements	Urban poor; women; children	Lower disease incidence; cleaner environment	Waste-sorting bins; larva-control kits	Hygiene promotion; community facilitation	2026–2035	Kemenkes; Kemen PU; Local Gov't
HS-05	Slow response to disease outbreaks	Digitalization of surveillance and health information	Digitalization of climate-sensitive disease surveillance (Satu Sehat Platform); mobile apps for case reporting and risk alerts	National; provincial health offices	Health officers; data managers	Faster reporting; better decision-making	ICT platforms; cloud servers	ICT literacy; analytics training	2026–2030	Kemenkes; KLH; BMKG; Universities
HS-06	Limited awareness and capacity among local health officials	Capacity development for climate-risk management	Capacity-building for provincial and district health offices on climate-risk assessment and adaptation budgeting	All provinces	Provincial & district health staff	Strengthened local health planning	E-learning platforms; training manuals	Risk-assessment and budgeting skills	2026–2035	Kemenkes; KLH; Bappenas
HS-07	Nutritional and sanitation stress in vulnerable communities	Integrating health in community-based adaptation	Integration of public-health modules into community resilience programs (Desa Sehat Tangguh Iklim, Posyandu Hijau, Desa Sehat Iklim) for nutrition and WASH co-benefits	Rural and peri-urban villages (NTT, East Java, West Kalimantan)	Women; children; youth	Improved nutrition; community empowerment	Seed kits; low-cost irrigation	Health promotion; facilitation skills	2026–2030	Kemenkes; Kemensos; Local Gov't; CSOs
HS-08	Rising mental-health and heat-stress risks	Mental-health and occupational-safety programs	Mental-health, psychosocial support, and heat-stress preparedness programs for frontline workers and urban communities, Mental Health information system	Urban heat-island zones (Jakarta, Surabaya, Makassar)	Health workers; outdoor laborers; urban poor; children & adolescents	Reduced heat-related illness; improved well-being	WBGT sensors; shelter materials; Heat monitoring systems	Occupational health management	2026–2030	Kemenkes; Local Gov't; Universities
HS-09	Vaccine spoilage and medicine degradation due to high temperature	Strengthening cold-chain resilience	Strengthening medicine and vaccine stockpailing and storage resilience through solar refrigeration and temperature monitoring, green procurement, logistic supply chain	All provinces; remote health centres	Patients; pharmaceutical supply chains	Stable vaccine potency; reduced wastage	Solar fridges; smart sensors	Cold-chain O&M; data management	2026–2030	Kemenkes; Kemen ESDM; PLN; Private Sector
HS-10	Delays in emergency health response during disasters	Integration of health early-warning into DRM systems	Integration of health-risk alerts into disaster early-warning systems and contingency planning, contingency plans for health clusters and environmental health emergencies	Disaster-prone provinces (Aceh, Central Sulawesi, East Nusa Tenggara)	Emergency responders; evacuees	Coordinated response; fewer casualties	Integrated EWS dashboards; SMS alerts	SOP training; inter-agency drills	2026–2035	Kemenkes; BNPB; BMKG; Local Gov't
HS-11	Limited research on climate-health linkages	Research and innovation on climate-sensitive diseases	Research and development on climate resilient health system (Air-quality and vector-disease modelling; health-impact assessment studies)	National universities; BRIN centres	Researchers; policymakers	Evidence for targeted adaptation	Modelling software; laboratory kits	Epidemiological and environmental research	2026–2035	Kemenkes; BRIN; Universities
HS-12	Lack of preparedness for compound climate–health emergencies	Strengthening emergency and recovery protocols	Emergency-preparedness protocols for compound events (flood + outbreak; extreme temperature + blackout); regular simulation drills	National; high-risk provinces	Hospitals; local health offices	Continuous service delivery; faster recovery	Mobile kits; logistics apps	Emergency management; coordination	2026–2035	Kemenkes; BNPB; Local Gov't; PLN

Annex 5. Sectoral Adaptation Matrix for Ecosystem

Impact Code	Impacts / Risks Addressed	Adaptation Action (ENDC Annex 2)	Feasible Adaptation Measure (Operational Detail)	Geographic Focus (Hotspots)	Beneficiaries	Benefits (Tangible & Intangible)	Technology Needs	Capacity & Skills Required	Timeline	Responsible Agencies
ES-01	Peatland degradation, recurring fires, and carbon emissions	Restoration and protection of peatlands	Forest and peatland restoration by rewetting through canal blocking; paludiculture promotion; community-based fire management (*Desa Peduli Gambut*)	Central Kalimantan, Riau, South Sumatra, Papua	Local farmers; forest-dependent communities	Fire risk reduction; livelihood diversification; water retention	Water-level sensors; fire-watch towers	Eco-hydrology design; community facilitation	2026–2030	Kemenhut; KLH; BRIN; Local Gov't
ES-02	Coastal erosion, saline intrusion, and habitat loss	Mangrove restoration and rehabilitation; integrated coastal management	Mangrove rehabilitation and coastal buffer strengthening for shoreline protection and blue-carbon storage	North Coast Java, South Sulawesi, East Kalimantan,West Papua; Papua	Coastal households; fishers; SMEs	Shoreline stabilization; blue-carbon sequestration	Sediment-trap models; drone mapping	Coastal nursery management; monitoring	2026–2035	KLH; KKP; Local Gov't; CSOs
ES-03	Catchment degradation and declining water quality	Watershed and riparian rehabilitation	Watershed and riparian rehabilitation through reforestation, terracing, and erosion control	Citarum, Way Sekampung, Mahakam basins	Farmers; water utilities; local communities	Improved infiltration; reduced sediment load; flood control; Increase in water quality index	GIS mapping; soil-stability sensors	Watershed O&M; agroforestry	2026–2035	KLH; Kemen PU; Kemenhut; Local Gov't
ES-04	Loss of biodiversity and ecosystem fragmentation	Establishment of biodiversity corridors and protected-area networks	Peatland rehydration and livelihood diversification (paludiculture, agroforestry, eco-tourism), Designation of ecological corridors linking highlands–lowlands–coastal systems (ridge-to-reef); law enforcement	Papua, Sulawesi, Nusa Tenggara	Local communities; conservation agencies	Species migration support; ecosystem connectivity	Remote-sensing & ecological modelling	Biodiversity monitoring; spatial planning	2026–2035	KLH; Kemenhut; BRIN; Local Gov't
ES-05	Frequent wildfires and haze events	Fire prevention and early warning systems	Fire prevention and early warning through satellite monitoring, community-partnered patrols, and controlled-burning bans, Weather Modification Technology	Sumatra, Kalimantan, South Papua	Farmers; local governments; industries	Reduced burned area; lower emissions	Hotspot-detection software; portable radios	Firefighting & emergency drills	2026–2030	KLH; Kemenhut; BMKG; BNPB
ES-06	Land degradation in post-mining and industrial zones	Rehabilitation of degraded land and post-mining areas	Rehabilitation of degraded land in mining and industrial areas with adaptive vegetation and ecological design	East Kalimantan; South Sumatra; Bangka Belitung	Mining communities; local governments	Restored land productivity; reduced erosion	Drone seeding; composting tech	Reclamation management; vegetation design	2026–2035	KLH; Kemenhut; ESDM; Private Sector
ES-07	Coral-reef bleaching and marine ecosystem degradation	Coral-reef rehabilitation and ecosystem monitoring	Coral-reef restoration and ecosystem monitoring using artificial reefs and reef nursery techniques	Bali, North Sulawesi, Maluku, NTT	Fishers; tourism operators; coastal youth	Restored reef structure; fisheries recovery; Blue Carbon ecosystem	Reef-building materials; underwater sensors	Diving & reef-restoration skills; community rangers	2026–2030	KKP; KLH; Local Gov't; Universities
ES-08	Decline in fish stocks and unsustainable coastal livelihoods	Sustainable fisheries and aquaculture management	Sustainable fisheries and aquaculture management integrating climate-risk criteria	North Sumatra, Sulawesi, NTB, Bali,	Fishers; aquaculture farmers	Income stability; reduced overfishing pressure	GIS zoning; feed innovation	Climate-smart aquaculture training	2026–2030	KKP; KLH; Local Gov't; Private Sector
ES-09	Weak data for ecosystem monitoring and adaptation planning	Strengthening national environmental information systems	Biodiversity corridor establishment connecting conservation areas (ridge-to-reef ecological networks)	National; priority ecoregions	Policy-makers; researchers; NGOs	Improved decision-making; transparency	Remote-sensing platforms; cloud storage	Data analytics; inter-agency coordination	2026–2030	KLH; BRIN; Bappenas
ES-10	Insufficient local capacity for EbA planning	Capacity development and training on ecosystem-based adaptation	Strengthening SRN-PPI and environmental monitoring (IKLH, ERI) with spatial and socio-ecological indicators	National	Local governments; universities; CSOs	Improved governance; knowledge sharing	E-learning modules; toolkits	Training-of-trainers (ToT)	2026–2035	KLH; Bappenas; Universities; NGOs
ES-11	Disaster risks exacerbated by degraded ecosystems	Ecosystem-based Disaster Risk Reduction (EbA-DRR)	Ecosystem-based disaster risk reduction (EbA-DRR) integrated in regional spatial planning (RTRW/RDTR) and ecosystem corridor connectivity	Coastal and watershed regions	Local governments; DRR agencies	Reduced flood/erosion impacts; enhanced safety	GIS hazard layers; hydrological models	Spatial-planning integration; DRR training	2026–2035	KLH; BNPB; Bappenas; Local Gov't; non-governmental actors.
ES-12	Weak stakeholder coordination and governance fragmentation	Strengthening coordination for integrated ecosystem management	Knowledge management and training for local governments on ecosystem-climate resilience and EbA , vulnerable groups climate campaign	National; priority landscapes	Multi-sectoral agencies; civil society	Policy coherence; efficient resource use	Collaboration platforms; governance dashboards	Multi-stakeholder facilitation	2026–2035	KLH; Kemenhut; Bappenas; BRIN

CONTRIBUTORS

Steering/National coordination

Ministry of Environment/Environmental Protection Agency (KLH/BPLH), Ministry of National Development Planning/National Development Plan Agency (Kemen PPN/Bappenas), Ministry of Finance (Kemenkeu), Ministry of Home Affairs (Kemendagri).

Implementing ministries and sectoral agencies

Ministry of Agriculture (Kementan), Ministry of Marine Affairs and Fisheries (KKP), Ministry of Public Works (Kemen PU), Ministry of Energy and Mineral Resources (Kemen ESDM), Ministry of Health (Kemenkes), Ministry of Forestry (Kemenhut), National Food Agency (Bapanas).

Cross-cutting institutions

Ministry of Social Affairs (Kemensos), Ministry of Agrarian Affairs and Spatial Planning (ATR/BPN), National Disaster Management Agency (BNPB), Meteorology, Climatology and Geophysics Agency (BMKG), Geospatial Information Agency (BIG), Statistics Indonesia (BPS), Ministry of Women's Empowerment and Child Protection (Kemen PPPA), Ministry of Micro, Small and Medium Enterprises (Kemen KUKM), Ministry of Villages and Disadvantaged Regions (Kemendesa), National Innovation and Research Agency (BRIN).

Non Party Stakeholders

Provincial Government of DKI Jakarta, Riau, Southeast Sulawesi, Lampung and Central Java, GIZ, UNDP, Mercy Corps Indonesia, WHO, UNICEF, WWF, ICLEI, Save The Children, UNFPA, UN Women and PIAREA.

Directorate of Climate Change Adaptation
Deputy of Climate Change and Carbon Governance
Ministry of Environment/Environmental Protection Agency
Republic of Indonesia

Address:
Gedung Plaza Kuningan, Menara Selatan Lt 3,
Jl. H. R.Rasuna Said, Karet Kuningan, Jakarta Selatan 12920
Website:
www. kemenlh.go.id
Email:
tudirektoratadaptasi@gmail.com